THE EFFECTS OF DEREGULATION ON RAIL RATES: A STUDY ON WHEAT, BARLEY, CORN, OAT, AND SOYBEAN

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

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ABSTRACT

Vinje, Daniel Martin; M.S.; Department of Agribusiness and Applied Economics; College of Agriculture, Food Systems, and Natural Resources; North Dakota State University; April 2006. The Effects of Deregulation on Rail Rates: A Study of Wheat, Barley, Corn, Oat, and Soybean. Major Professor: Dr. John Bitzan.

Although the original intent of this study was to do a pre-and post-deregulation assessment of rail rates per ton-mile, the results using post-deregulation data show a significant decrease in rail rates between 1981 and 2000. While accounting for changes in shipment characteristics, savings for wheat, barley, corn, oat, and soybean shippers were 63.80%, 69.17%, 49.07%, 67.97%, and 59.36%, respectively. Rate savings over time for an average 1981 shipment were 45%, 55%, 38%, 45%, and 36% for wheat, barley, corn, oat, and soybean shippers, respectively.

Analysis regarding the effects of deregulation of rail rates on corn, soybean, and wheat on a regional basis shows that rail rates not only differ across commodities, but also among regions. In general, it was found that grain producers within regions that had higher levels of intermodal competition had lower rates than their counterparts with lower levels of intermodal competition. Distribution of benefits as a result of market-based pricing has varied among regions, and these variances are increasing over time.

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TABLE OF CONTENTS

ABSTRACT......iii

ACKNOWLEDGMENTS......iv

LIST OF TABLES......vi

LIST OF FIGURES......vii

LIST OF EQUATIONS......ix

CHAPTER 1. INTRODUCTION......1

CHAPTER 2. REVIEW OF LITERATURE......6

CHAPTER 3. METHODOLOGY......21

CHAPTER 4. DATA......32

CHAPTER 5. RESULTS......41

CHAPTER 6. CONCLUSIONS......73

REFERENCES CITED......76

APPENDIX......79

LIST OF TABLES

Table		Page
4.1	Wheat weighted averages, 1981-2000	35
4.2	Barley weighted averages, 1981-2000	36
4.3	Corn weighted averages, 1981-2000	37
4.4	Oat weighted averages, 1981-2000	38
4.5	Soybean weighted averages, 1981-2000	39
5.1	Base model for wheat, barley, corn, oat, and soybean	42
A.1	Simulation results: intermodal wheat model	79
A.2	Simulation results: intramodal wheat model	79
A.3	Simulation results: intermodal barley model	80
A.4	Simulation results: intramodal barley model	80
A.5	Simulation results: intermodal corn model	81
A.6	Simulation results: intramodal corn model	81
A.7	Simulation results: intermodal oat model	82
A.8	Simulation results: intramodal oat model	82
A.9	Simulation results: intermodal soybean model	83
A.10	Simulation results: intramodal soybean model	83
A.11	Intermodal and intramodal elasticities for wheat, barley, corn, oat, and soybean	84

LIST OF FIGURES

Figure | Page

1. Time effect simulation of rates per ton-mile for wheat, barley, corn, oat, and soybean, 1981-2000 46

2. Cumulative percentage decrease in rates for wheat, barley, and soybean, 1981-2000, relative to 1981 48

3. Cumulative percentage decrease in rates for corn and oat, 1981-2000, relative to 1981 48

4. Simulated rates for wheat, barley, corn, oat, and soybean, 1981-2000. 49

5. USDA production regions 50

6. Average number of cars by originating region for corn, 1981-2000 52

7. Average short-line distance by originating region for corn, 1981-2000 53

8. Average distance of shipment origins from nearest barge loading facility for corn, 1981-2000 54

9. Average Herfindahl Index of origin railroad concentration by region for corn, 1981-2000 55

10. Simulated corn rates by region, 1981-2000 56

11. Simulated corn rate savings due to time trend and due to changes in time and shipment characteristics, 1981-2000 57

12. Average number of cars per shipment by originating region for soybean, 1981-2000 59

13. Average short-line distance by originating region for soybean, 1981-2000 59

Figure		Page

14. Average distance of shipment origins from nearest barge loading facility for soybean, 1981-2000 60

15. Average Herfindahl Index of origin railroad concentration by region for soybean, 1981-2000 61

16. Simulated soybean rates by region, 1981-2000 61

17. Simulated soybean rate savings due to time trend and changes in time and shipment characteristics, 1981-2000 62

18. Average cars per shipment by originating region for wheat, 1981-2000 63

19. Average short-line distance of wheat shipments by region, 1981-2000 64

20. Average distance of shipment origin from the nearest barge loading facility for wheat shipments, 1981-2000 65

21. Average Herfindahl Index of origin railroad concentration by region for wheat shipments, 1981-2000 66

22. Simulated wheat rates by region, 1981-2000 66

23. Simulated wheat rate savings due to time trend and due to changes in time controlling for shipment characteristics, 1981-2000 68

LIST OF EQUATIONS

Equation Page

1. Rate per ton-mile (RPTM) in reduced form 22
2. Herfindahl-Hirschman Index 24
3. Rate per ton-mile estimation 24
4. Total effect of time since degregulation on RPTM 29
5. The effects of intermodal competition on rail rates 30
6. The effects of intramodal competition on railroads over time 31

CHAPTER 1
INTRODUCTION

Background

Prior to the passage of the Staggers Act of 1980, railroads were subject to close scrutiny imposed under regulation. Rates were set and coordinated by rate bureaus to equalization levels often benefiting the least efficient rail providers. Unprofitable branch lines were forced to be maintained and serviced, and railroad mergers were discouraged. Contract rates were limited to certain commodities (MacDonald, 1989).

During the 1970s and into the early 1980s, major industries such as the communication, financial, and energy industries were undergoing regulatory reform. At this time, transportation industries were also experiencing initial acts of legislation that eventually progressed toward the reformation of the railroad industry. Congress began regulatory reform by offering more operating freedoms under the Railroad Revitalization and Regulatory Reform (4R) Act of 1976. The 4R Act gave the railroads greater pricing flexibility and eased restrictions on railroad track rationalization and mergers. Significant regulatory changes did not occur, however, until the introduction of confidential contract rates, regulatory exemption on certain commodities, and the encouragement of rail rationalization by the Interstate Commerce Commission (ICC) in 1979 (MacDonald, 1989).

As summarized by MacDonald (1989) and others, the Staggers Rail Act of 1980 offered railroads the freedom to restructure rates and services and to discontinue services and abandon unprofitable service lines. The act also broadened the use of confidential contract rates set between railroads and shippers. Cooperative rate equalization within regions was effectively eliminated through the elimination of rate bureaus. This resulted in competitive pricing and the acceleration of restructuring shipments from single car shipments to multi-car or unit train movements. With the passage of the Staggers Act of 1980, railroads were essentially deregulated, with the exception of routes for which they held market dominance.

Economists predicted that regulatory reform would lead to lower prices and significant welfare gains to consumers (Winston, 1993), and several studies since deregulation have examined the accuracy of these predictions. These studies have examined rail rate changes, changes in railroad profitability, and railroad productivity gains.

In general, studies have found that most shippers have benefitted from increased competition among railroads and from reductions in rail costs. Railroads have abandoned unprofitable branch lines, upgraded remaining lines, and restructured rates–providing incentives for shippers to use less costly shipping methods (MacDonald, 1989).

The freedom to restructure rates from cost-based to market-based has provided incentives for railroads to reduce costs. Reductions in costs have been achieved through the abandonment of unprofitable rail lines, through increased traffic densities resulting from regaining previously lost traffic,[1] and from enhancements in rail technology (productivity gains). Further, many of these cost savings have been passed on to shippers. With the exception of certain commodities and shippers located in geographical regions where

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[1]For a recent analysis of cost savings resulting from increased traffic densities from deregulation, see Bitzan and Keeler (forthcoming in JLE, 2007).

demand for rail transportation is less elastic than others, railroads have not been able to use their rate-making freedom to earn excess profits (McFarland, 1989).

As previously mentioned, studies have shown that increased productivity, decreased rates, and increased profitability in the rail industry can be attributed to deregulation. While evidence suggests that benefits have been shared by shippers, in terms of rate savings and improved service, the degree to which these benefits have been realized to bulk grain shippers needs to be examined further to serve as benchmarks for efficient design of future regulations.

Problem Statement

Although the number of studies into the effects of deregulation of railroads are numerous and the focus of research has varied, pressing legislative issues require current analysis of cost and benefit sharing. To correctly address the call to re-regulation brought about by the perceived disparity of a small group of bulk shippers such as those in regions with little intermodal and intramodal competition, further analysis must be conducted (Molinari, 2001). This study focuses on the effects of deregulation to shippers with differing levels of transportation competition, on how these effects differ between regions, and on the extent that rate savings/increases have been experienced between the period of deregulation up to the year 2000.

Before making further policy changes in the way railroads are regulated, it is imperative that policy makers understand the full impacts of past regulatory change and the implications that such impacts have for formulating future rail transportation policy. This research will enhance the information base available to policy makers, such as Congress, the Surface Transportation Board, and the United States Department of Agriculture, by documenting an important impact of past regulatory change.

Objectives and Overview of the Thesis

This study examines rail rate changes resulting from deregulation, with a focus on how rate changes have differed by commodity, level of competition, and changes in technology. Specific objectives of the study are listed below:

(1) Identify general grain commodity classifications to be used for rate analysis. By focusing on wheat, barley, corn, oat, and soybean separately, the varying rate structure within each grain commodity will be examined.

(2) Formulate and estimate statistical rail rate models to examine the effects of deregulation on rates, focusing on differences among shippers with varying elasticities of demand for rail service. Specifically, the effects of variables affecting the elasticity of demand for rail service on deregulation rate impacts will be assessed. For example, the model will show how the effects of deregulation on rates have varied with differences in railroad concentration, the level of waterway access, and proximity to major markets.

(3) Assess rail deregulation's impacts on rates, by commodities, and how they have varied for shippers in different regions. The assessment will include an application of rate function parameter estimates to hypothetical post deregulation shipments to illustrate the effects of factors influencing the elasticity of demand for rail service on rate changes resulting from deregulation. In addition, the assessment will examine the time effects of deregulation and how they have differed among grain commodities and regions.

The main section of this thesis begins with a Review of Literature. In the Review of Literature is a discussion of previous studies to examine the impact of deregulation on rail rates of commodities, effects on groups such as shippers, profitability of railroads since deregulation, and the impact of deregulation on rates within regions. In addition, a detailed discussion of two studies by MacDonald (1987, 1989) examines grain shipments and the effects of differing levels of intramodal and intermodal competition on rail rates.

Following the Review of Literature, the thesis proceeds with a theory chapter that explains the theoretical basis of the empirical model used in this study. After the theory chapter, the empirical methods are discussed. This chapter explains the model formulations and variations in the dependent variable, Rate Per Ton-Mile (RPTM). This chapter also includes a detailed description of independent variables used in the model, with an explanation of expected signs. After this chapter, the study moves into a descriptive data section. It is in this chapter where the source of data is discussed, along with the strengths and weaknesses of using the Waybill Sample Data. The fifth chapter presents the Results of the estimations on rail rates for specific grain commodities within regions. Also, an examination into the variation of rates existing within the grain commodity, as well as the effects of time since rail deregulation, are presented. In the final chapter, there is a summarization of the findings and a discussion of policy implications.

CHAPTER 2
REVIEW OF LITERATURE

The objective of this study is to investigate the rate structure in the rail industry and how it has changed as a result of deregulation, paying particular attention to the differential impacts that deregulation has had on rates within grain commodities, regions, and over time. This chapter examines the research that has been done in this area as follows. The first section introduces the readers to the history of the rail industry and how it operated under regulation. The second section gives an overall assessment of the effects of deregulation. The third section provides a background of research that has been conducted previously and the methods that the authors used in their studies. The final section highlights model formulations and discusses different sources of data used in the models.

History of the Rail Industry Under Regulation

In 1970, the bankruptcy of the nation's largest railroad, Penn Central, along with six other northeastern railroads, provided insight into the financial demise of the railroad industry under regulation. Penn Central was bailed out through the creation of a public corporation called Conrail as a result of The Regional Rail Reorganization Act of 1973 (3-R Act) . Due to the possibility of other bailouts occurring, policymakers sought to remedy the profit-making restrictions imposed on the railroad industry by regulation. Congress sought regulatory reform to give railroads more operating freedoms in hopes of avoiding future bailouts by passing the Railroad Revitalization and Regulatory Reform (4R) Act of 1976.

The 4R Act gave the railroads greater pricing flexibility, and eased restrictions on railroad track rationalization and mergers. Significant regulatory changes did not occur, however, until the introduction of confidential contract rates, regulatory exemption on certain commodities, and the encouragement of rail rationalization by the ICC in 1979 (MacDonald, 1989).

In 1980, The Staggers Rail Act was enacted, representing one of the most dramatic changes in federal policy toward railroads since the Interstate Commerce Act of 1887–the Act responsible for creation of the Interstate Commerce Commission (ICC). The Interstate Commerce Act introduced railroad regulation based on the premise that the railroad industry was a natural monopoly that required ICC regulation. In contrast, the Staggers Act was based on the notion that competition is generally adequate to constrain any potential abuses by railroads (Fuller et al, 1987).

The major aspects of the Staggers Act were (1) increased rail rate flexibility, (2) authorization of confidential shipper/rail contracts, (3) limited regulatory control over joint rates and routes, (4) provision for mandatory reciprocal switching agreements to encourage competition, and (5) accelerated abandonment and merger decisions (Babcock et al, 1985).

The Staggers Act allowed railroads to negotiate individual and confidential contract rates with shippers for any commodity–a significant change from previous practice. Railroads were able to adjust their rates downward as a result of the new rate-making freedom, allowing railroads to compete more effectively with other modes of transportation, such as barges or trucks.

By stimulating competition and increasing operating freedom, deregulation gave the railroad industry the drive to transform itself by achieving a much better match between its huge physical plant and work force on the one hand, and available traffic on the other. Some of the transformations the industry made were decreasing network sizes from rail abandonment and the reduction of crew sizes.[1] Contracts were used to align cars and equipment with shippers' demands and to reduce vulnerability to problems caused by overcapacity. Other transformations were made, such as the expansion of the use of intermodal operations, double-stack rail cars, and computer systems to provide faster, more reliable services. Real operating costs per ton-mile have steadily declined since deregulation. Some of the 60% cost decline from 1980 to 1998 can be attributed to the long-run trend in rail's traffic mix to include a greater proportion of low-cost bulk traffic, but a significant portion is due to deregulation (Peltzman & Winston, 2000).

In the next section, previous studies of the effects of deregulation are examined. In general, these studies have found that railroads experienced increases in productivity and earnings, while shippers experienced a decrease in rail rates, since the passage of the Staggers Act.

Overall Assessment of Deregulation

Numerous studies have been conducted to examine the effects of deregulation on rail profitability, costs, and rates. Although each study is unique, results in general have found that deregulation has increased earnings, increased rail productivity, and allowed

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[1] For an analysis of the impacts of crew size changes on railroad costs, see Bitzan and Keeler (2003).

shippers to benefit through a decrease in rail rates.

Some studies conducted prior to the Staggers Act suggested that railroads would reap either monopolistic profits or experience decreased profitability. However most studies conducted since deregulation have found decreased rail rates and increased rail profitability. Burton (1993) found that railroads have increased their responsiveness to both intramodal and intermodal competition since the passage of the Staggers Act. Burton concluded that railroads have shared productivity benefits of deregulation with rail shippers by offering lower rates for almost all commodities.

In McFarland's (1989) study, railroads were not found to experience excess profits after deregulation. This finding discounts deregulation opponents' fear that railroad rate-making freedom without regulatory supervision would lead to monopoly pricing. An extension to McFarland's study found that the indirect effect of deregulation was increased profit realized through reduced costs (Bitzan, 1994).

McFarland also found that labor productivity had substantially increased since deregulation, while shippers benefitted from improvement in service without an increase in rail rates. Wilson's (1992) aggregate study on 34 different commodity classifications over a 17-year period suggests that advances in productivity dominated any adverse market power effects. Initially, rates for some commodities rose under deregulation, implying greater market power and modest cost savings. By 1988, however, deregulation resulted in lower rates for most commodity classifications. This suggests that advances in productivity dominated any adverse market power effects. Dennis (2000) estimated that shippers saved close to $28 billion per year, most of which is the result of railroad productivity gains.

In his study, McFarland suggests that shippers with highly inelastic demand for rail transportation, such as coal shippers, have seen rate increases. In their case study of the market for low-sulfur Wyoming coal, Atkinson and Kerkvliet (1986) found that since deregulation railroads and coal producers have engaged in price discrimination at the expense of utility buyers. Similarly, some argue that grain shippers in the Northern Plains have not received large benefits from deregulation due to their relative captivity to a particular railroad. Further, it has been argued that "captive" rail shippers have recently experienced rate increases.

While many studies have generalized that shippers have benefited from the effects of deregulation, others such as McFarland's (1989) study have also pointed out that there were segments of shippers that have not benefited. In this study, this small segment of shippers can be characterized as experiencing increased shipping rates due to a lack of intermodal and intramodal competition brought about through geographical conditions or rail-line abandonments.

Moreover, some shippers have expressed concern about the perceived inequity of rail rates that has resulted from the use of unit trains in regions of the U.S. where intramodal and intermodal competition have been minimal. To remain competitive, many shippers have invested in expanding their infrastructure to fulfill capacity levels and loading time restrictions required to qualify for unit train rates. The segment of shippers who have been unable to do so have complained that they have been treated unfairly. As a result of such concerns, the Senate recently introduced the The Railroad Competition Act of 2005 "to help limit the impact of railroad monopolies on captive shippers" (Montana's

United States Senator Conrad Burns, 2005).

The Railroad Competition Act of 2005 would clarify existing laws and direct the Surface Transportation Board (STB) to ensure effective competition among rail carriers at origins and destinations, maintain reasonable rates in the absence of effective competition, and maintain consistent and efficient rail transportation for rail shippers–including the timely provision of cars. The bill would also establish a final offer arbitration of rail rates disputes between shippers and the railroad companies (Montana's United States Senator Conrad Burns, 2005).

Not surprisingly, groups such as Consumers United for Rail Equity (C.U.R.E.) along with sixteen associations representing wheat growers, utility companies, forest, chemical, cement, coal, and other industries are in support of this legislation (Stainsby, 2005). The Association of American Railroads warns that this legislation would lead to reregulation which would result in reduced rail capacity, higher costs, reduced service, increased traffic on over-crowded highways, and ultimately a government bailout of the railroad industry (AAR, 2006).

Whether such large changes in regulations are desirable depends, at least in part, on the extent to which past regulatory change has benefited shippers. If most shippers have gained from regulatory change, any potential benefits to a small group of shippers seem to be outweighed by the potential detriment to other shippers and the industry in general. A review of previous studies and the impacts of deregulation on rail rates demonstrates the various methods and models used and the differing results found in these studies.

Previous Studies

Several studies about the effects of deregulation on railroad rates have been conducted. These studies have varied in their methods, model formulation, and level of data aggregation. For example, studies by Boyer (1987) and McFarland (1989) examine aggregate U.S. rail rates. Other studies, including those by Babcock et. al (1985), Barnekov and Kleit (1990), Burton (1993), and MacDonald (1989), examine changes in rail rates for different shippers of a specific commodity, such as coal or grain. Finally, studies by Wilson (1992) and Dennis (2000) have examined changes in aggregate rail rates for a variety of individual commodities.

One of the first studies conducted after the passage of the Staggers Act was Boyer's (1987) aggregate study of railroad rate levels and market share. In contrast to most studies in this area, Boyer concluded that the most likely effect of deregulation was an increase in rates, although his estimations showed no statistically significant effects from deregulation.

Two possibilities may explain the results of Boyer's study. In his examination of average revenues per ton-mile, individual rate changes may have been unobservable due to the use of aggregate data. The other possibility, as pointed out in Bitzan's (1994) study, is the low number of observations used in Boyer's estimations.

In Barnekov and Kleit's (1990) dissaggregate study on coal and grain rates, the authors concluded that efficiency gains from deregulation were between $11.5 and 18.5 billion per year. The authors found two fundamental faults with Boyer's study. First, according to the authors, the rate level model used was improperly specified, resulting in an incorrect conclusion about how price was affected by deregulation. Second, Boyer's model fell short in examining the impacts of deregulation on cost levels and service quality by failing to look at the welfare gains due to more efficient methods and practices now allowed by deregulation. Rate declines should be considered as a result of net efficiency gains–and not just a transfer from producers to consumers.

In their estimations, Barnekov and Kleit measure the gradual implementation of the Staggers Act in the context of a reduced form model. This countered the alleged misspecification of previous studies, which implied that effects of deregulation were immediately realized once Staggers was enacted. As pointed out by Barnekov and Kleit, deregulatory processes were proceeding at a slow pace before the Staggers Act, and once it was passed, it took many months for the Interstate Commerce Commission to execute the changes. It took railroads and shippers even longer to respond to the radical changes advised by the new law.

According to Barnekov and Kleit, the most important aspect of the Staggers Act was the contract provision, which legalized rail service contracts, giving total confidentiality of contract rates and terms. Prior to 1980, very few contracts were made. However, by 1987 the rate at which contracts were made increased to 1650 per month.

As the number of years since deregulation progressed, researchers such as Barnekov and Kleit (1990) and Wilson (1994) have concluded that railroad rates have in fact declined. Barnekov and Kleit estimated that annual welfare gains in the United States from rail deregulation were between \$5.3 and \$7.2 billion in lower rates to shippers, \$5 to \$10 billion in reduced inventory-related logistic costs, less than \$500 million in higher profits to railroads, and slightly more than $700 million in savings to taxpayers. Therefore, their estimate of the total annual gain from rail deregulation was $11.5 to $18.5 billion.

In an impact study of the Staggers Act on Kansas wheat markets by Babcock et. al (1985), the authors concluded that rail rate reductions appeared to be responses to market conditions created by many events, including a reduced export flow of wheat, surpluses of transport equipment, changes in transport technology and cost relationships, and others. Deregulation had allowed flexibility for adjustments to market conditions resulting in farmers benefiting from reduced rail rates. As a result, the authors suggested that although many small shippers adjusted well to deregulation, other small shippers feared possible injury through the dependence on a single railroad and their limited ability to negotiate with the carrier.

One unique study that examined the effects of deregulation across 34 commodity classifications was conducted by Wesley Wilson (1992). Wilson's study found the theoretical effects of deregulation depended on the nature of pricing under regulation and deregulation, the level of cost savings, and the elasticity of demand. Deregulation would negatively influence rates if cost savings were achieved with little or no increase in market power. On the other hand, if market power increased as a result of deregulation, rates could increase. As a result, tradeoffs occurred between cost savings and increased markups over marginal costs. These tradeoffs produced price effects that varied across commodities–effects that were lost in studies of rates where all commodities were aggregated.

His analysis of deregulation outcomes on 34 different commodity classifications over a 17-year period suggested dramatic differences across commodity classifications, not only in terms of the magnitude of effects, but also in terms of direction. Initially, rates rose for the majority of commodities under deregulation, implying greater market power and modest costs savings. However, by 1988 deregulation produced lower prices in most commodity classifications and did not produce price increases in the other classifications–suggesting that advances in productivity had dominated any adverse market power effects. Variations in the effects of deregulation are partially explained by differences in the characteristics of commodities.

Although the economic benefits to railroad deregulation are well established, policy issues have surfaced recently, primarily focusing on the reasons why railroad rates have declined since deregulation. On one side of the debate, a number of shippers claim that rates have fallen due to changes in railroad traffic characteristics such as an increasing percentage of bulk commodities, increased length of haul, and increased private ownership of equipment. On the other side, the railroad industry contends that the reductions are a result of cost savings due to heavier ladings, increased shipment size, and improved technology (Dennis 2000).

In a recent study examining the impacts of deregulation on rail rates, Dennis (2000) examined railroad revenue per ton-mile over a variety of commodities. The top ten commodities accounting for ninety percent of rail revenue were selected. Dennis used a reduced form railroad rate equation to determine the factors influencing the decline of the railroad rates since the Staggers Act. In his study, Dennis determined that changes in commodity mix, length of haul, shipment size, lading weight, equipment ownership, railroad costs, competition from other modes, and demand for railroad transportation were factors in railroad rates. By running separate regressions for each of ten major two-digit Standard Transportation Commodity Code (STCC) commodities, the commodity mix was controlled, and effects were allowed to vary across commodities. Data on traffic characteristics and the regression coefficients were used to calculate the total differential of the rate equation. Changes in revenue per ton mile were applied to 1996 commodity traffic levels to determine the annual savings to shippers.

His estimations showed that, as a result of railroads' reduced revenue per ton-mile, shippers saved $28 billion per year in 1996 dollars between 1982 and 1996. Ninety percent of the rate reductions were due to productivity-adjusted railroad cost reductions. Increased length of haul and increased private ownership of equipment cited by some shippers accounted for only about 2% of the reduction in railroad revenue per ton-mile since deregulation.

Another series of studies were James MacDonald's disaggregate studies of grain rail rates and their change as a result of deregulation. His research of the significance of intermodal competition and intramodal competition on rail rates for specific commodities is of particular relevance to the current study.

In MacDonald's (1987) study of corn, wheat, and soybean rail shipments from domestic production areas to ports for export, it was found that the farther a shipper was from competing water transportation, the higher rail rates were. In addition, he found that, as the number of railroads competing in a region increased, rail rates declined. His estimations also found that there was some interaction between intermodal and intramodal competition. The closer the shipper was to water competition, the less important was the influence of intramodal competition.

In the 1987 study, MacDonald chose to focus on the export shipments of corn, wheat, and soybean due to the ability to observe variations in competitive conditions across disaggregated locations. This was accomplished by using the Interstate Commerce Commission (ICC) Annual Rail Waybill Sample data for 1983. According to MacDonald, fundamental market characteristics such as grain market demand elasticities, spoilage, or loading characteristics do not vary across origin locations. Thus, rate differences are due to differences in shipment characteristics such as length of haul, size and competition.

In the case of corn, competition among railroads and among railroads and barges constrain rail rates in several ways. First, elevators with favorable transport rates can offer higher bid prices to farmers, attracting grain away from competing local elevators that may be served by competing railroads. Second, elevator operators facing high rail rates can ship by truck (short-haul rail) to other elevators on competing rail or barge lines. The critical factor in restraining railroad market power in the first two cases is the cost of truck transport (MacDonald, 1987). Finally, some elevators are served by competing rail or barge lines. In this case, elevators will ship on the railroad offering lower rates.

Elevator operators marketing wheat and soybean in the Corn Belt area have the same alternatives as those marketing corn. Elevators operating in the wheat production centers in the Southern Plains (Texas, Oklahoma, and Kansas), the Northern Plains (Nebraska, North and South Dakota, Montana, and Minnesota), and the Northwest (Washington and Idaho), face a different shipping scenario. Wheat areas have poor access to competing water transport in comparison to corn and soybean production areas (except for Washington locations, which are near to the Columbia River). In 1987, the eastern parts of the plains states usually had access to several rail lines, but other areas only had access to one or two railroads (MacDonald, 1987).

MacDonald also concluded that water competition appeared to be far less important for wheat, and that wheat regions had a low number of intra rail competitors. With the geographic restriction to water access, shippers in the major wheat regions with limited intermodal and intramodal competition were also more likely to be captive shippers and single carload sellers. He also found that commodities differed in shipment sizes. Corn usually moved in unit trains, while wheat moved in small one- to three-car shipments at the time of the study.[2]

In an extensive study for the United States Department of Agriculture published in 1989, MacDonald examined the effects of railroad deregulation on grain transportation. In the study, he addressed the issue of whether the effects of deregulation varied across regions and commodities. MacDonald chose to use wheat, corn, sorghum, barley, and soybean as the focus of his study for several reasons. His primary reason for examining grain was the wide dispersal of grain production across the United States. Second, the accuracy of the assessment regarding the effects of competition on rail rates as a result of deregulation could be validated with these commodities due to the wide variety of competitive conditions that occur across grain regions. Finally, unobservable dimensions

[2] In a study by Vachal, Bitzan, and Tolliver (1996), the authors found that unit train use in 1994 had virtually equaled other types of multi-car options in the transportation of North Dakota grain and oilseeds.

of service quality, such as speed, reliability of service, and susceptibility to damage, were less important for grain than for other commodities.

Consideration was given by MacDonald to the use of publicly quoted tariff rates, origin-destination grain price spreads, and the Waybill Sample as sources of data for his estimations. The Waybill Data Sample was chosen because it was the only source to measure shipment sizes and rates that could be used to determine commodity flows between regions. The one major drawback of the Waybill Sample was the inaccuracy of reported unit train movements prior to 1981, particularly for coal and corn.

Results of MacDonald's regression analysis suggested that wheat rates dropped an average of 21.7% in the years 1981-1985 with no controls for shipment size shifts, and 15.5% with controls. Corn rates declined by 12.4% with no controls, and 8.4% with controls. According to his analysis, about 30% of the rate decline could be attributed to the spread of multiple-car and unit train use.

Competition among railroads was also found to have had a strong effect on rates. Lower rates were found to be associated with an increase in the number of competitors, which was especially true when the distance from barge competition was increased. In MacDonald's estimation, wheat shippers located 500 miles from water competition paid rates 36% greater than shippers 100 miles away. Corn rates also increased with distance from water competition, though the increase was smaller due to corn producers' close proximities to water competition. Corn shippers 200 miles away paid rates 6.2% greater than shippers 75 miles away from water competition.

MacDonald concluded the following: Staggers Act reforms accelerated the costreducing adaptations of multiple-car and unit train operations. This shift would also lead to a greater trend toward consolidation of grain merchandising, resulting in fewer but larger elevators. This may have lead to rural road deterioration, as farmers invested in heavier trucks to move loads greater distances.

Deregulation also introduced competition among railroads in regions with evidence of effective cooperation before Staggers. MacDonald also found that Class I railroads had reduced their systems through abandonments and sales, and many short-line and regional railroads had taken over light-density branch lines.

The next chapter discusses the methodology, model, and data used in determining rate differentials among regions in the United States using grain movements for wheat, barley, corn, oat, and soybean from 1981 to 2000.

CHAPTER 3
METHODOLOGY

This chapter discusses the theory of rail rate determination, the specific model used to estimate rates with an explanation of variables used and their expected signs, and simulations designed to demonstrate the impact of intermodal and intramodal competition on rail rate savings.

Theory

One of the objectives of this study is to determine if captive shippers realized the same rate savings from deregulation as shippers located in markets with more transportation options. As previously discussed, a combination of geographical and competitive factors[1] affect the elasticity of demand for rail service. Shippers located in regions such as western North Dakota and Montana experience higher rail rates due to a more inelastic demand for rail transportation in comparison to areas with more transportation options. Differences in the demand elasticities for rail transportation between regions is accounted for by the differences in proximity to competitive modes of shipping and by differences in railroad to railroad competition. Increased intermodal options, such as nearby water access and close proximity to terminal markets, make elasticity of demand for

[1]Although geographic and product competition are not measured directly, their influence on demand elasticity is reflected in different rates across different commodities. Geographic competition is competition among railroads able to supply the same product to a destination, but originating at different sources, or competition among railroads able to ship an originating product to different destinations. Product competition is competition among railroads at different locations in shipping substitute products.

rail service higher. Shippers who have an increased number of railroad (intramodal) options from which to choose will also experience lower rates for a particular rail service due to a higher elasticity of demand for a particular railroad's service.

Rail rates are determined by the interaction of the demand for rail service and supply of rail services. As demand for rail by shippers increases, rates increase. Conversely, rates decline as demand for rail service decreases. Moreover, factors that increase the elasticity of demand for rail service will decrease rates. As costs increase, supply decreases and causes an increase in rates, while rates will decrease if cost decreases.

In this study, rail rate per ton-mile is specified as a reduced form equation of variables affecting the supply and demand for rail services.

$$R = R(c,d,t), \tag{1}$$

where

R= Rate per ton-mile
c = a vector of operating and supply characteristics
d = a vector of variables affecting demand
t = time trend since deregulation

Revenue per ton-mile (also referred to as "rate per ton-mile") is a function of operating and supply characteristics, demand factors, and time.[2] The vectors of operating and supply characteristics include factors influencing costs such as the rail distance from origination to destination, the commodity weight per car, and the number of cars per

[2]Time trend is an indicator of technological changes and changes in pricing practices since deregulation over time.

shipment.[3] Cost relationships should be reflected in rates since relevant demand factors are also controlled. Distance, commodity weight per car, and cars per shipment all have an inverse relationship with rail costs per ton-mile and are expected to have an inverse relationship with rate per ton-mile.

The distance to barge loading facilities is used as a variable influencing demand elasticity.[4] Since commodity movements by barge are a major competitor to the rail industry for long-haul shipments of bulk commodities, it would be expected that, as the distance from barge loading facilities increases, elasticity of demand for rail service will decrease and rate per ton-mile will increase.

Another demand variable measures the market share of each railroad in the originating counties and the number of railroads (Herfindahl-Hirschman Index). It is expected to have a positive relationship with rate per ton-mile. Defined as the sum of the squared market shares (tons) of all railroad firms in the county of origin, the Herfindahl-Hirschman Index measures the market power of railroad firms in a county. This number falls between 0 and 1, with 0 representing perfect competition and 1 representing a pure monopoly. Higher railroad market power is associated with a lower elasticity of demand for a particular railroad's service and, consequently, higher rates.

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[3]Other railroad rate studies have used similar operating and supply characteristics. For example see MacDonald (1989) or Bitzan (1994), or for other variations of the rate model, see McFarland (1989).

[4]Ibid.

$$\text{Herf} = \sum_{i=1}^{n} \left(S_i^2\right), \tag{2}$$

where S_i = Share of railroad *i* in all railroad tons of grain originating in a county.

Model

This study presents an Ordinary Least Squares (OLS) estimation of rail rates per ton-mile for all wheat, barley, corn, oat, and soybean movements by rail in the continental United States for the years 1981 to 2000. All continuous variables, except time, are in natural logarithms, which allows the coefficients to be interpreted as elasticities.

The specific model used to estimate the impact of deregulation on rail rates per ton-mile for grains in this study for the years 1981 through 2000 is as follows:

$$\begin{aligned} \ln RPTM = {} & \beta_0 + \beta_1 \ln CARS + \beta_2 \ln LOAD + \beta_3 \ln SHRT + \beta_4 \ln BDIST + \beta_5 TIME + \\ & \beta_6 \ln HERF + \beta_7 \ln GPROD + \beta_8 TCOMP + \beta_9 TIME * \ln BDIST + \\ & \beta_{10} TIME * \ln HERF + \beta_{11} S1 + \beta_{12} S2 + \beta_{13} S1 * \ln BDIST + \\ & \beta_{14} S2 * \ln BDIST + \varepsilon \ , \end{aligned} \tag{3}$$

where

RPTM = Rate per ton mile
CARS = Number of cars per shipment
LOAD = Commodity weight per car
SHRT = Shipment distance in miles
BDIST= Distance from nearest barge loading facility
(Measured from the center of originating county)
TIME = Time indicator 1981= 0, 1982=1,1983=2...2000=19
HERF = Herfindahl-Hirschman Index
GPROD =Total U.S. grain production (1000/bushels)
TCOMP = Truck competition; dummy variable; 1 if termination of shipment is within 279 miles, 0 otherwise.
S1 = Seasonal indicator; dummy variable December-March
S2 = Seasonal indicator; dummy variable April-July

As several components of rail costs, such as cost of switching, classifying, and loading cars, are fixed with respect to distance, they decrease on a per-mile basis as distance increases. Costs and rates per mile should decline with distance, according to MacDonald (1989). Short line miles (SHRT), which is defined as the shortest rail distance between origin and destination, is used to measure distance. Because demand variables are also accounted for, an inverse relationship is expected between distance and revenue per ton-mile.[5]

LOAD (commodity weight per car) should have a negative relationship with rate per ton- mile, since the cost per ton-mile decreases with increases in shipment weight. Costs such as clerical, switching, and labor costs remain the same regardless of weight per car. Thus, increases in the average weight per car should reflect negatively on rates per ton-mile.

Similarly, CARS should also have an inverse relationship with rates per ton mile. Switching yard and classification costs increase very little with shipment size, as do labor and administration costs. Therefore, costs per ton decline with increasing tonnage due to increased shipment sizes, (MacDonald, 1989).

Two demand variables capture variations in the elasticity of demand for rail service. One, HERF, measures the level of intramodal competition, while BDIST measures

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[5]This model assumes that the parameter estimates stay the same over time, with the exception of the two demand elasticity parameter estimates. Changes in demand elasticity parameter estimates reflect changes in rate making from cost-based pricing to market-based pricing over time since deregulation.

the level of intermodal competition. HERF is expected to have a positive relationship with rail rates. Defined as the sum of the squared market shares (tons) of all railroad firms in the county of origin, the Herfindahl-Hirschman Index measures the market power of railroad firms in a county. This number falls between 0 and 1, with 0 representing perfect competition and 1 representing a pure monopoly. HERF decreases with increasing numbers of carriers and increases with rising inequalities among a given number of carriers. In this study, it is expected that HERF should have a positive relationship with rates. That is, as the market power of carriers increases (indicative of less railroad-to-railroad competition), rates increase.

Distance to nearest barge loading facilities (BDIST) is also expected to have a positive influence on rates. Despite their limited flexibility to serve origins/destinations and handle small shipments, barges are very active in the grain industry. They offer the low-cost alternative for long distance, bulk-product shipments. As the distances from barge competition increases, rates are expected to increase. In this study, BDIST is used to measure the strength of intermodal competition. The greater the distance from a barge loading facility, the less likely that elevators will use the truck/barge combination due to higher costs. (i.e., Trucks are more competitive at shorter distances.)

Another demand variable measuring the level of intermodal competition is truck competition, TCOMP. TCOMP is a dummy variable that is 1 if the termination of rail movement is within 279 miles of origination; 0 otherwise. A study by Tolliver and Bitzan (1997) found that at distances less than 279 miles, trucks are cost competitive with rail.

TCOMP is expected to have a negative sign due to a higher elasticity of demand for rail service for truck competitive shipments.

A variable that measures the overall level of demand for grain rail service in this study is GPROD. It is defined as the total U.S. annual grain (wheat, barley, corn, oat, sorghum, rye, and soybean) production as cited on the National Agricultural Statistics Service website. It is expected that the relationship between RPTM and GPROD will be positive, signifying that as the demand for rail shipment increases, rail rates will increase.

To measure the impact of deregulation on rail rates, the TIME variable will show the year-to-year trend in RPTM. TIME is expected to be inversely related to RPTM, as the rail industry has had greater pricing flexibility and cost savings in the deregulated environment. Originally, the intent of this study was to evaluate rail rates pre and post deregulation. However, it was deemed necessary to limit the study to the years after 1981, due to inaccuracies found in pre-deregulation data.[6]

Included in the model were interaction terms to allow an assessment of the differing impacts of deregulation as a result derived from differing levels of transportation competition and over time. TIME*HERF is expected to have a positive relationship with rail rates due to increased pricing flexibility from deregulation. As railroads pursue more market-based rates as a result of deregulation, factors influencing demand elasticity should be more important in determining rates.

The interaction term TIME*BDIST should also have a positive relationship with rail

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[6]This will be covered further in the next chapter.

rates. The more competitive rail pricing becomes as the passage of time since deregulation increases, the larger the influence of intermodal competition on rates.

When the intermodal and intramodal competition variables are interacted with TIME, (i.e., TIME*HERF or TIME*BDIST), it is to be expected that the positive relationships with rail rates would be reinforced further as time passes since deregulation, due to a switch from cost-based pricing to market-based pricing.

To measure the seasonal effects of rail rates, the dummy variables S1 and S2 were introduced into the model. S1 equals 1, if the period when the origination of rail movement is between the months of December and March, or 0 if otherwise. Similarly, for S2 equals 1 if the origination of rail movement is between the months of April and July, or 0 if otherwise. These variables are interpreted in relation to season 3 (August-November), which is the dummy left out of the model. Signs for S1 and S2 are expected to be negative, since the demand for rail shipments will decrease during the winter and spring months, resulting in a decrease in rail rates.

S1 and S2 are interacted with ln BDIST to measure the different effects on rail rates from barge competition when movements on the Upper Mississippi are reduced or terminated during winter freeze-up.[7] The resulting interaction terms S1*BDIST and

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[7]According to the office of U.S. Army Corps of Engineers located in St. Paul, Minnesota, winter freeze-up for the Upper Mississippi is between the months of December and March. Although the actual period during which river barge movement is terminated due to freezing conditions is shorter than four months, the locks and dams are generally closed during the period of December through March due to maintenance and repairs.

S2*BDIST are expected to capture effects of barge competition on rates during the periods between December and March (S1), and April through July (S2). It is expected that the sign for S1*BDIST will be negative, as the rate discipline introduced by barge competition is limited during this period. In the next section, partial derivatives of the base model will be highlighted to show how time effects vary with different levels of intramodal and intermodal competition.

Derivatives

To determine the impact intermodal and intramodal competition have had on rail rates since deregulation, this study will use simulations based on partial derivatives taken from the base model equation for the following grain commodities: wheat, barley, corn, oat, and soybean. The total effect of time since deregulation on rate per ton-mile can be determined by taking the partial derivative of the equation for RPTM with respect to time as follows:

$$\frac{\partial \ln RPTM}{\partial Time} = \beta_5 + \beta_9 * \ln BDIST + \beta_{10} * \ln HERF$$

(4)

Since both interaction terms are expected to have a positive relationship with RPTM, it is expected that rate decreases over time will be smaller for areas with less intramodal and intermodal competition. One purpose of this study is to determine if captive shippers have experienced rate changes differently than shippers faced with more, elastic demand. This can be illustrated by simulating the time effects for various levels of intramodal and intermodal competition using the above derivative.

An alternative way to look at the same problem is to ask how the role of competition is influencing rate changes over time. If captive shippers have experienced lower rate decreases as a result of deregulation, then competitive variables have become more important in determining rates. To isolate the effects of intermodal competition on rail rates over time, the partial derivative of the natural log of RPTM with respect to the natural log of BDIST is taken. This equation is mathematically shown as follows:

$$\frac{\partial \ln RPTM}{\partial \ln BDIST} = \beta_4 + \beta_9 TIME \tag{5}$$

This is interpreted as the percentage change in RPTM given a 1% change in distance to the nearest barge loading facility. In this study, the partial derivative will depend on time since deregulation. Simulating the effect of BDIST on RPTM in the time period immediately after deregulation up to the year 2000 is accomplished by setting TIME at those periods (i.e., 0 = 1981, 1 = 1982, 2 = 1983, ..., 19 = 2000). It is expected the effect of intermodal competition will have a stronger influence on rates over time since deregulation. That is, as more time passes since the implementation of deregulation, the greater the positive relationship on rates for shippers located farther away from intermodal competition. This is based on the theory that pricing for rail services switched from cost-based to market-based pricing.

To isolate the effects of the level of intramodal competition on rail rates over time, the partial derivative of the natural log of RPTM with respect to the natural log of HERF is calculated mathematically shown as follows:

$$\frac{\partial \ln RPTM}{\partial \ln HERF} = \beta_6 + \beta_{10} TIME \tag{6}$$

This is interpreted as the percentage change in RPTM given a 1% change in the level of intramodal competition as represented by the Herfindahl-Hirschman Index. The parameters β_6 and β_{10} are also expected to have positive signs. Intramodal competition is expected to increase in importance over time. Equivalently, as the time since deregulation increases, a given increase in concentration will have a bigger influence on rates. Whether higher concentration plays a more important role over time will be assessed based on this partial derivative.

In the next chapter, data will be discussed, specifically the variables derived from the Waybill Data. Descriptive statistics will also be presented.

CHAPTER 4
DATA

This chapter will discuss in detail the data set used in the empirical model, along with the advantages and disadvantages of Waybill Sample Data. Explanations of how some variables are calculated for use in the model are also provided.

The primary source of data for the analysis is the Surface Transportation Board's[1] (STB) Annual Rail Waybill Sample, Master File for the period 1981-2000.[2] This provides a data set rich in both cross-sectional and time-series information. Initially, approximately 244,000 observations were in the data set. After eliminating outliers and missing data, about 240,000 observations are included in the sample.

When utilizing the Waybill Sample it is important to consider cautions of Wolfe (1986) concerning the sampling rate, contract revenue, billed vs. actual weight, and the Accounting 11 Rule. Wolfe points out that the under-reporting of unit train movements prior to deregulation may have led to an inaccurate sampling rate. Instead of a 1% sampling rate from the years 1946 to 1980, it is suggested that the rate was actually between 0.8% and 0.9%. For this reason, this study does not use pre-1981 data. Caution is also given to using contracted revenues in any analysis due to the possibility of overstatement of rail

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[1]Formerly known as the Interstate Commerce Commission (ICC).

[2]Initial attempts were made to extend the scope of the study by including the Annual Rail Waybill Sample Master File from 1972 through 2000. After considering cautionary remarks from the STB concerning the accuracy of the pre-1981 data, it was deemed necessary to drop the data from the study in order to ensure accurate results.

revenues in order for rail companies to retain confidentiality. However, recent analysis suggests this impact is small.[3] Using billed weights could also lead to biased results due to a difference between billed and actual weights, which is estimated to affect 2% of the data. It was difficult to make an assessment of the consistency between billed and actual weight in this study since actual weight is missing in most cases. Finally, Wolfe (1986) points out that the use of Accounting Rule 11, which allows railroads to rebill long-distance traffic as local movements, can make single-line movements appear to be two separate moves. There is no way to assess the extent of this problem for the current study.

Another issue to address is that, prior to 1984, the variable for short-line miles was often left blank in the Waybill Sample. To correct for this, short-line distances between an origin and destination county in years later than 1984 were used to fill in the prior omitted distances. It was assumed that the distance from county A to county B was the same, regardless of what year the shipment occurred. Two variables added to the Waybill Sample were distance to the nearest barge loading facility and the Herfindahl-Hirschman Index. The Herfindahl-Hirschman Index (HERF) is calculated as the sum of all railroad firm shares squared in the county of origin (Equation 2). The level of intermodal competition was measured by using highway distances to the nearest barge loading facility (BDIST) from the county in which the rail shipment originates.

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[3]Dennis (2000) addressed Wolfe's (1986) cautions by comparing rate per ton-mile (RPTM) data derived from the Waybill Sample to those derived from the Association of American Railroads' (AAR) Freight Commodity Statistics (FCS) database. Dennis found that an overall adjustment factor of 3% was needed for both revenue and tonnages in the Waybill Sample database to match FCS values.

Descriptive statistics for wheat, barley, and corn shipments are discussed in the next section–specifically weighted averages for rate per ton (RPT), rate per ton-mile (RPTM), SHRT (distance of shipments), LOAD (commodity weight per car), CARS (number of cars per shipment), distances to nearest barge loading facility (BDIST), and the average for Herfindahl-Hirschman Index (HERF).

Tables 4.1-4.5 present weighted averages of rates, distances, weights per car, shipment size, and competitive variables for wheat, barley, corn, oat, and soybean, respectively. In general, averages RPTM, representing rates per ton-mile in real terms, respectively, are decreasing after the implementation of deregulation: 58%, 71%, 46%, 74%, and 56% for wheat, barley, corn, oat, and soybean, respectively. However, regional effects cannot be evaluated by these tables. Another item worth noting is that corn has had lower RPT and RPTM than wheat and barley before and after deregulation, possibly due to the geographic location of originating corn shipments and the earlier use of unit-train shipments.[4] This is also reflected in the higher number of cars for corn in comparison to the lower number for wheat and barley. The average in the number of cars per shipment for each commodity has increased overall, and in some cases significantly, since 1981: 438%, 311%, 465%, 95%, 874% for wheat, barley, corn, oat, and soybean, respectively.

Average shipment distances for wheat, barley, oat, and soybean show a shift from shipments terminating regionally toward terminating at distances further away since

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[4]MacDonald (1989) found that 94% of corn shippers originate within 200 miles of ports. Corn export movements were primarily accomplished by unit-trains or multi-car shipments prior to 1981.

Table 4.1. Wheat weighted averages, 1981-2000.

Year	RPT*	RPTM**	SHRT	LOAD	CARS	BDIST***	HERF****
1981	28.93	0.062	463.56	94.94	1.41	226.44	0.751
1982	26.45	0.045	581.49	100.29	2.28	232.27	0.769
1983	25.85	0.045	575.96	98.29	2.78	239.06	0.789
1984	21.25	0.038	559.01	97.92	3.70	228.26	0.739
1985	19.82	0.038	521.68	97.00	3.71	238.17	0.755
1986	18.21	0.031	581.57	96.47	4.51	235.49	0.773
1987	17.04	0.028	598.83	96.58	5.21	240.88	0.781
1988	17.61	0.028	615.37	95.98	6.55	223.68	0.774
1989	15.80	0.029	543.24	92.70	9.05	214.97	0.783
1990	18.73	0.029	647.86	91.89	7.54	236.67	0.802
1991	18.40	0.026	702.75	96.11	8.57	231.87	0.799
1992	18.95	0.026	730.20	97.60	8.75	255.92	0.799
1993	20.81	0.028	746.03	97.95	8.86	264.56	0.802
1994	23.15	0.031	758.86	94.11	6.60	245.50	0.772
1995	22.47	0.029	778.51	98.28	5.71	254.38	0.792
1996	22.29	0.028	808.90	98.81	5.87	238.78	0.808
1997	22.20	0.029	770.46	97.75	5.23	237.93	0.688
1998	20.79	0.029	728.43	99.63	5.81	237.73	0.819
1999	20.47	0.027	747.65	100.54	5.84	229.95	0.820
2000	19.60	0.026	766.46	101.70	7.59	226.06	0.864

* = Rate per ton.
** = Rate per ton-mile.
*** = Distance to barge loading facility.
**** = Herf index for Stcc (01) Farm commodity.
RPT and SHRT = Averages weighted by ton.
RPTM = Averages weighted by ton-mile.
LOAD = Averages weighted by cars.
CARS = Averages weighted by expansion factor.

Table 4.2. Barley weighted averages, 1981-2000.

Year	RPT*	RPTM**	SHRT	LOAD	CARS	BDIST***	HERF****
1981	40.21	0.092	432.30	83.92	1.04	241.44	0.729
1982	36.46	0.049	736.39	85.83	1.14	262.86	0.836
1983	34.30	0.054	628.51	87.47	1.44	285.15	0.847
1984	31.97	0.056	561.90	87.23	1.54	294.74	0.850
1985	29.57	0.050	580.65	89.29	1.39	282.73	0.831
1986	29.81	0.039	745.61	89.78	1.76	289.73	0.819
1987	25.35	0.037	679.19	89.75	2.40	288.67	0.840
1988	28.05	0.040	697.77	89.50	2.32	247.35	0.823
1989	27.03	0.039	689.88	89.94	2.28	264.10	0.796
1990	29.15	0.035	829.61	90.06	2.51	274.23	0.794
1991	28.54	0.031	902.34	90.35	2.60	270.68	0.816
1992	24.44	0.033	738.31	90.66	3.04	283.34	0.851
1993	26.02	0.030	862.75	91.69	3.73	292.72	0.852
1994	21.73	0.033	658.06	90.31	3.45	257.58	0.662
1995	22.96	0.035	653.55	91.85	3.04	253.55	0.797
1996	23.32	0.031	751.93	92.91	2.99	266.22	0.845
1997	21.75	0.029	729.07	92.62	3.26	247.35	0.638
1998	20.67	0.030	672.72	93.80	2.96	238.71	0.800
1999	21.17	0.028	749.74	95.12	2.94	262.43	0.826
2000	22.17	0.027	795.37	94.16	4.27	275.91	0.824

* = Rate per ton.
** = Rate per ton-mile.
*** = Distance to barge loading facility.
**** = Herf index for Stcc (01) Farm commodity.
RPT and SHRT = Averages weighted by ton.
RPTM = Averages weighted by ton-mile.
LOAD = Averages weighted by cars.
CARS = Averages weighted by expansion factor.

Table 4.3. Corn weighted averages, 1981-2000.

Year	RPT*	RPTM**	SHRT	LOAD	CARS	BDIST***	HERF****
1981	29.62	0.037	790.22	94.13	2.25	96.34	0.771
1982	23.40	0.031	748.28	96.96	4.31	79.61	0.757
1983	23.21	0.031	742.86	96.72	5.37	82.80	0.729
1984	24.32	0.028	842.63	96.59	6.45	90.11	0.751
1985	18.88	0.025	737.02	96.24	6.60	80.31	0.759
1986	17.30	0.025	673.65	96.56	6.26	72.51	0.752
1987	16.60	0.023	694.19	96.15	7.76	79.37	0.788
1988	17.43	0.023	736.58	96.44	9.02	88.55	0.790
1989	17.46	0.023	750.29	96.33	10.27	91.60	0.793
1990	17.92	0.024	738.77	95.23	8.97	91.88	0.802
1991	17.92	0.024	721.78	94.86	9.31	91.80	0.808
1992	17.25	0.025	688.90	95.51	9.48	91.00	0.814
1993	17.08	0.024	690.28	95.32	9.44	83.94	0.802
1994	16.40	0.025	637.89	95.45	8.66	84.47	0.751
1995	19.98	0.022	878.59	97.49	9.68	89.95	0.724
1996	18.89	0.023	804.73	98.50	8.16	93.07	0.740
1997	19.68	0.023	853.39	96.43	10.06	96.57	0.650
1998	17.95	0.022	788.14	100.42	11.13	91.41	0.772
1999	18.03	0.021	843.35	101.58	10.66	95.06	0.767
2000	18.13	0.020	897.40	101.61	12.72	91.29	0.775

* = Rate per ton.
** = Rate per ton-mile.
*** = Distance to barge loading facility.
**** = Herf index for Stcc (01) Farm commodity.
RPT and SHRT = Averages weighted by ton.
RPTM = Averages weighted by ton-mile.
LOAD = Averages weighted by cars.
CARS = Averages weighted by expansion factor.

Table 4.4. Oat weighted averages, 1981-2000.

Year	RPT*	RPTM**	SHRT	LOAD	CARS	BDIST***	HERF****
1981	33.16	0.095	349.84	62.32	1.06	97.97	0.723
1982	32.40	0.046	712.09	67.62	1.06	133.78	0.794
1983	29.72	0.063	473.57	69.46	1.30	157.86	0.751
1984	25.35	0.061	413.33	71.46	1.40	144.28	0.747
1985	22.09	0.052	425.00	72.35	1.20	177.40	0.771
1986	21.22	0.048	445.38	73.07	1.25	130.56	0.706
1987	19.49	0.044	442.33	75.23	1.28	188.84	0.735
1988	15.89	0.047	337.20	75.98	1.70	129.86	0.738
1989	14.72	0.044	336.54	75.77	2.39	125.07	0.673
1990	14.96	0.046	325.41	76.55	2.27	102.57	0.607
1991	13.61	0.044	312.17	77.61	2.27	118.56	0.671
1992	16.39	0.037	445.47	76.47	2.41	145.25	0.780
1993	14.91	0.034	444.97	78.72	2.53	105.47	0.646
1994	13.38	0.033	401.33	80.68	3.32	119.31	0.525
1995	17.30	0.033	532.94	82.06	2.34	101.43	0.536
1996	19.32	0.031	634.22	82.20	1.54	115.70	0.634
1997	18.50	0.031	606.23	81.23	1.64	130.62	0.591
1998	16.48	0.031	536.89	79.82	2.02	125.70	0.695
1999	17.37	0.029	606.53	84.52	1.99	91.12	0.575
2000	16.37	0.025	655.17	84.68	2.07	79.76	0.808

* = Rate per ton.
** = Rate per ton-mile.
*** = Distance to barge loading facility.
**** = Herf index for Stcc (01) Farm commodity.
RPT and SHRT = Averages weighted by ton.
RPTM = Averages weighted by ton-mile.
LOAD = Averages weighted by cars.
CARS = Averages weighted by expansion factor.

Table 4.5. Soybean weighted averages, 1981-2000.

Year	RPT*	RPTM**	SHRT	LOAD	CARS	BDIST***	HERF****
1981	20.14	0.046	442.90	92.79	1.60	64.61	0.997
1982	18.81	0.033	573.94	97.27	3.10	79.85	0.997
1983	15.72	0.034	464.55	96.55	4.17	81.20	0.996
1984	15.71	0.033	480.63	95.66	5.07	79.15	0.811
1985	13.75	0.030	457.15	94.72	4.42	87.18	0.805
1986	12.77	0.024	525.18	95.63	5.09	81.64	0.765
1987	11.62	0.022	519.30	95.40	6.60	77.51	0.799
1988	13.27	0.025	521.08	94.40	7.34	81.25	0.796
1989	13.64	0.026	513.56	94.78	6.35	85.25	0.794
1990	13.20	0.026	504.01	94.83	6.98	86.48	0.823
1991	13.13	0.025	517.91	95.22	8.55	85.45	0.807
1992	13.54	0.024	559.72	95.26	9.58	79.69	0.819
1993	13.60	0.023	580.68	95.82	10.29	83.65	0.830
1994	12.77	0.023	556.99	96.76	8.40	93.05	0.803
1995	15.49	0.022	695.90	95.96	8.09	102.94	0.765
1996	15.43	0.023	675.26	97.22	7.99	111.01	0.744
1997	16.03	0.022	723.58	96.42	9.14	119.59	0.703
1998	15.26	0.022	701.21	97.19	8.54	122.15	0.760
1999	16.15	0.021	763.73	98.64	9.52	136.14	0.775
2000	16.39	0.020	831.77	97.66	15.58	111.45	0.789

* = Rate per ton.
** = Rate per ton-mile.
*** = Distance to barge loading facility.
**** = Herf index for Stcc (01) Farm commodity.
RPT and SHRT = Averages weighted by ton.
RPTM = Averages weighted by ton-mile.
LOAD = Averages weighted by cars.
CARS = Averages weighted by expansion factor.

deregulation, possibly due to an increase in exports or a shift in the location of terminals for these commodities. Percentage increases in shipment distances are 65%, 84%, 14%, 87%, and 88% for wheat, barley, corn, oat, and soybean respectively Averages for LOAD of all commodities show an increase, illustrating the change from 70-ton cars to 100-ton hoppers. Percentage increase in weight per car is 7%, 12%, 8%, 36%, and 5% for wheat, barley, corn, oat, and soybean, respectively.

Average distances to barge load facilities (BDIST) for wheat and barley are higher than the other commodities. Wheat and barley producers, in most cases, are located in geographic locations where intermodal competition is less available. Average distances in miles to nearest barge loading facilities is 236, 269, 88, 126, and 92 for wheat, barley, corn, oat, and soybean, respectively. HERF averages also indicate a slight shift toward an increase in market power of railroads competing within a county in most commodities with the exception of soybean. Average percentage increase/decrease in the Herfindahl-Hirschman Index is 15%, 13%, 0.5%, 12%, and -21% for wheat, barley, corn, oat, and soybean, respectively.

In the next chapter, the parameter estimates of rate models for wheat, barley, corn, oat, and soybean are presented, along with simulations of rate changes among regions.

CHAPTER 5
RESULTS

In this chapter, the parameter estimates of the regressions for wheat, corn, barley, oat, and soybean are highlighted. Discussion is also given to simulations used to estimate how deregulation impacts have varied with varying levels of intermodal and intramodal competition and within regions for corn, soybean, and wheat. Finally, conclusions and policy implications are presented.

Empirical Results

Overall, the estimated model provides a good explanation of variations in rail rate per ton-mile. As shown in Table 5.1 for most of the grains covered in this study, over 70% of the variation in the dependent variable is explained by the models.[1] For the most part, the estimated models show the expected relationships between the explanatory variables and the rail rates per ton-mile.[2] As expected, the natural log of the number of rail cars (lCARS) and the commodity weight of each car per shipment (lLOAD) have negative signs and are significant. This suggests that as the number of cars and the commodity weight of each rail car increases, the rate per ton-mile decreases. The natural log of the distance per shipment (lSHRT) is negative and significant, suggesting that, as the distance per shipment

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[1]Oat R-square was 68%.

[2]Exceptions include the wheat model, in which the interaction variable TIME*ln HERF has an unexpected negative sign and is insignificant. In the barley model, TIME*ln HERF is negative. In the corn model, lnHERF, and TIME*BDIST are unexpectedly negative. In the oat model, lHERF is insignificant, and TIME*ln HERF has an unexpected negative sign. In the soybean model, lnBDIST, and TIME*lnHerf have unexpected negative signs.

Table 5.1 Base model for wheat, barley, corn, oat, and soybean.

Variable (Standard Error)	Wheat	Barley	Corn	Oat	Soybean
Intercept	-1.33*	1.99*	1.42*	0.541	-0.336**
	(0.13423)	(0.22941)	(0.11062)	(0.484)	(0.19045)
lcar	-0.06*	-0.038*	-0.056*	-0.057*	-0.031*
	(0.00143)	(0.00355)	(0.00089)	(0.00913)	(0.0017)
lload	-0.301*	-0.677*	-0.724*	-0.526*	-0.716*
	(0.00579)	(0.01551)	(0.00492)	(0.01653)	(0.00824)
lshrt	-0.646*	-0.612*	-0.46*	-0.597*	-0.544*
	(0.00219)	(0.00337)	(0.00173)	(0.00877)	(0.00308)
lbdist	0.113*	0.066*	0.03*	0.019*	-0.011*
	(0.00217)	(0.00278)	(0.00185)	(0.00589)	(0.003)
time	-0.036*	-0.062*	-0.015*	-0.038*	-0.046*
	(0.00106)	(0.00147)	(0.00082)	(0.00278)	(0.00133)
lherf	0.059*	0.323*	-0.019*	0.021	0.282*
	(0.00594)	(0.01261)	(0.00495)	(0..02303)	(0.01228)
lgprod	0.025*	0.122*	0.0971*	0.157*	0.240*
	(0.00810)	(0.01340)	(0.00664)	(0.02939)	(0.01149)
tcomp	-0.069*	-0.1375*	-0.043*	-0.084*	-0.058*
time*lbdist	0.0009*	0.004*	-0.002*	0.001**	0.004*
	(0.00019)	(0.000276)	(0.00018)	(0.0006)	(0.0003)

Table 5.1. (continued)

Variable (Standard Error)	Wheat	Barley	Corn	Oat	Soybean
time*lherf	-0.00028	-0.025*	0.008*	-0.004***	-0.017*
	(0.00067)	(0.00127)	(0.00048)	(0.00214)	(0.00109)
s1	-0.388*	-0.011***	-0.001	-0.009	-0.022*
	(0.00386)	(0.00649)	(0.00276)	(0.01289)	(0.0047)
s2	-0.011*	0.005	0.02*	0.013	-0.002
	(0.00352)	(0.00683)	(0.00285)	(0.0139)	(0.0051)
s1*lbdist	0.024*	-0.005**	0.013*	-0.003	-0.011*
	(0.0017)	(0.000211)	(0.00128)	(0.00601)	(0.00266)
s2*lbdist	0.018*	-0.005**	-0.007*	-0.011**	-0.009*
	(0.0016)	(0.00208)	(0.00124)	(0.00587)	(0.00215)
Observations	99484	21803	110442	4304	30864
Adjusted R-sq	0.7142	0.7981	0.6885	0.7372	0.7638

* = Significant at 1% level.
** = Significant at 5% level.
*** = Significant at 10% level.

lcar = Natural logarithm of number of cars per shipment.
lload= Natural logarithm of commodity weight per car.
lshrt= Natural logarithm of shipment distance in miles.
lbdist= Natural logarithm of distance from nearest barge loading facility.
time= Time indicator 1981=0, 1982=1, 1983=2...2000=19.
lherf= Natural logarithm Herfindahl-Hirschman Index.
lgprod= Natural logarithm of total U.S. grain production(1000/bushels).
tcomp= Truck competition; dummy variable; 1 if termination of shipment is within 279 miles, 0 otherwise.
s1= Seasonal indicator; dummy variable December-March.
s2= Seasonal indicator; dummy variable April-July.

increases, rail carriers pass on economies realized. The distance to the nearest barge loading facility (lBDIST) is positive[3] and significant at the 1% level, indicating that shippers experience an increase to the rail rate per ton-mile as the distance to the nearest barge loading facility is increased. The Herfindahl-Hirschman Index (lHERF) is positive,[4] indicating that rail rate per ton-mile increases as intramodal competition decreases. The natural log of the total grain production in the United States (lGPROD) is positive and is significant. This suggests that, as total grain production increases, demand for rail shipments increases, resulting in an increase in rail rates per ton-mile.

Other variables of interest in this study are the time, truck competition, and seasonal dummies. The time variable (TIME), which in this study is used to measure the deregulation effect, is significant and negative for all grains. This indicates that, as time since deregulation increases, rail rates per ton-mile decrease. The effect of truck competition (TCOMP) is negative, suggesting that, if the distance of a rail shipment was within 279 miles, rail rates per ton-mile decreased due to the increased likelihood of truck competition.

The interaction variable TIME*ln BDIST is positive[5] and significant at the .05 level, suggesting that intermodal competition has a bigger influence on rates as time since

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[3] With the exception of soybean having a negative coefficient for lBDIST.

[4] lHERF for corn is negative, and lHERF for oat is insignificant.

[5] Interaction term TIME*ln BDIST is negative for corn.

deregulation increases. When time is interacted with the natural log of Herfindahl- Index (TIME*lnHERF), the sign is unexpectedly negative.[6] It was expected that increased market-based pricing would make intramodal competition more important in determining rates after deregulation.

The unexpected negative signs may reflect technology improvements in the trucking industry and elevator capacity. As the trucking industry has increased its trailer lengths and fuel economy, it has increased economical shipping distances, resulting in an important intermodal alternative. Elevators have increased their capacities to accommodate unit-trains and remain competitive. As a result, these larger elevators are competing over larger areas. Consequently, the concentration of railroads in a particular county may no longer be a relevant measure of intramodal competition. That is, while concentration within a county probably represented a good indicator of the role played by cross country competition in limiting rates in 1981, concentration over a much broader area is probably more appropriate today.

When seasonal dummies, season 1 and season 2, are interacted with the natural log of barge distances, (S1FBD and S2FBD respectively), interactions are negative with the exception of the wheat model. This suggests the influence of intermodal competition is less significant on rail rates during these particular time periods.

One of the primary objectives of this study is to determine the effect that time had on rail rates since deregulation for wheat, barley, corn, oat, and soybean. Since deregulation

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[6]Time*lnHerf for corn is positive and significant. For oat, Time* lnHerf is significant at the 10% level.

occurred in 1980, changes in rates after 1981 reflect the effects the deregulation has had on rail rates.[7] Figure 1 shows simulated rate per ton-mile for wheat, barley, corn, oat, and soybean when placing all variables, except time, at the 1981 mean levels for the entire period.

The simulation shows the changes in rates that have occurred for an average

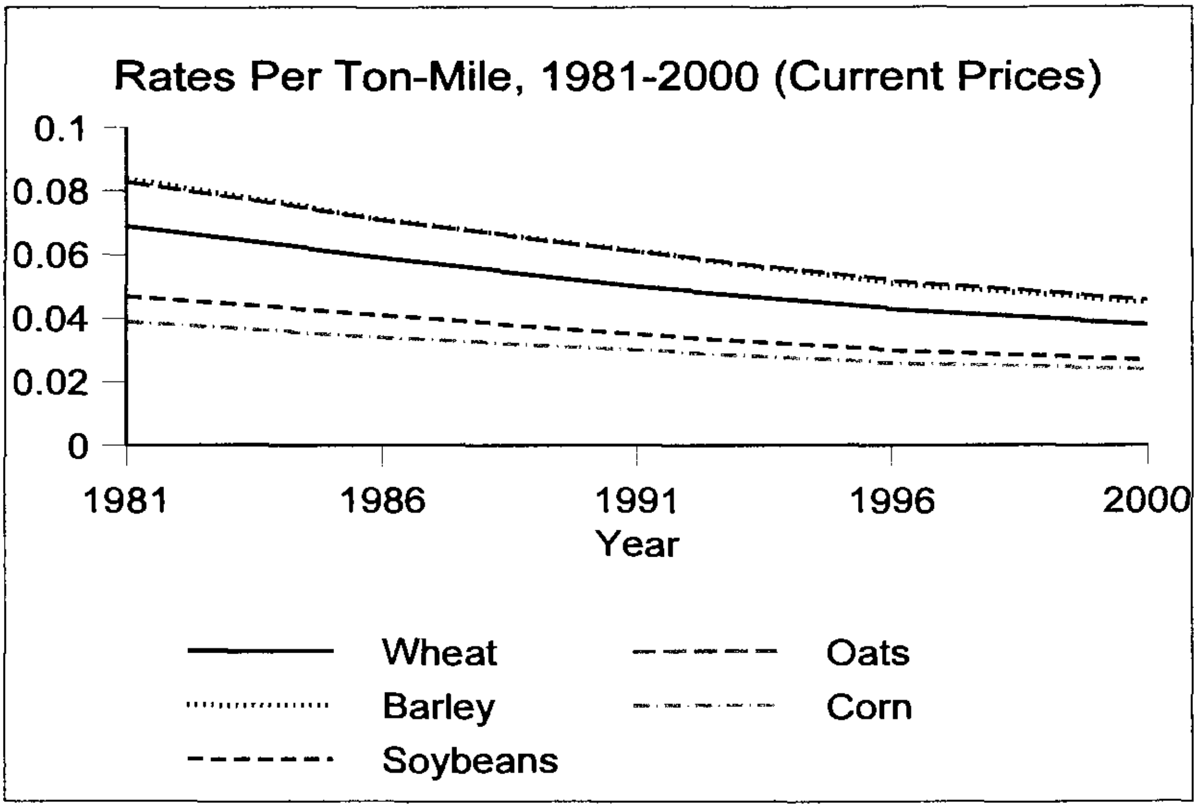

Figure 1. Time effect simulation of rates per ton-mile for wheat, barley, corn, oat, and soybean, 1981-2000.

[7]Due to a lack of pre-deregulation data, the change in rates over time does not necessarily identify a deregulation impact. It is possible the post-deregulation trend was a continuation of a pre-deregulation trend. Nonetheless, the large negative impacts of time on rates are strongly suggestive of a deregulation impact.

shipment solely due to changes in the parameters over time.[8] This simulation might be considered the direct effect of deregulation.[9] In general, rail rates for wheat, barley, corn, oat, and soybean have decreased since 1981. However, the differences in rates between commodities have diminished toward the year 2000. The overall percentage decrease in RPTM due to time only is 45%, 47%, 38%, 45%, and 44% for wheat, barley, corn, oat, and soybean, respectively.

Figures 2 and 3 show the percentage changes in rates of shipments simulated at yearly mean levels for all variables, relative to 1981. These simulations potentially demonstrate the direct and indirect influence that deregulation had on rates, including those from increases in shipment size, length of haul, weight, etc. However, it is important to note that this study has not identified the impact of deregulation on those other variables. It is likely that shipment size, length of haul, weight, etc. increased due to a variety of factors as a result of deregulation.

As the figures show, all five commodities show significant decreases in rates relative to 1981. The most dramatic decrease in rates in the year 2000 relative to 1981 occurred for wheat, barley, and oat with percentage decreases in rates in the upper 60% range: 64%, 67%, and 69%, respectively. Corn experienced the lowest percentage decrease in rates at 49% with soybean following at 59%.

The simulations represented in Figures 2 and 3 also show an immediate drop in rate

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[8]Recall that BDIST and HERF are interacted with time.

[9]Indirect effects of deregulation may also have occurred due to changes in shipment size, distance, load factors, or concentration from deregulation.

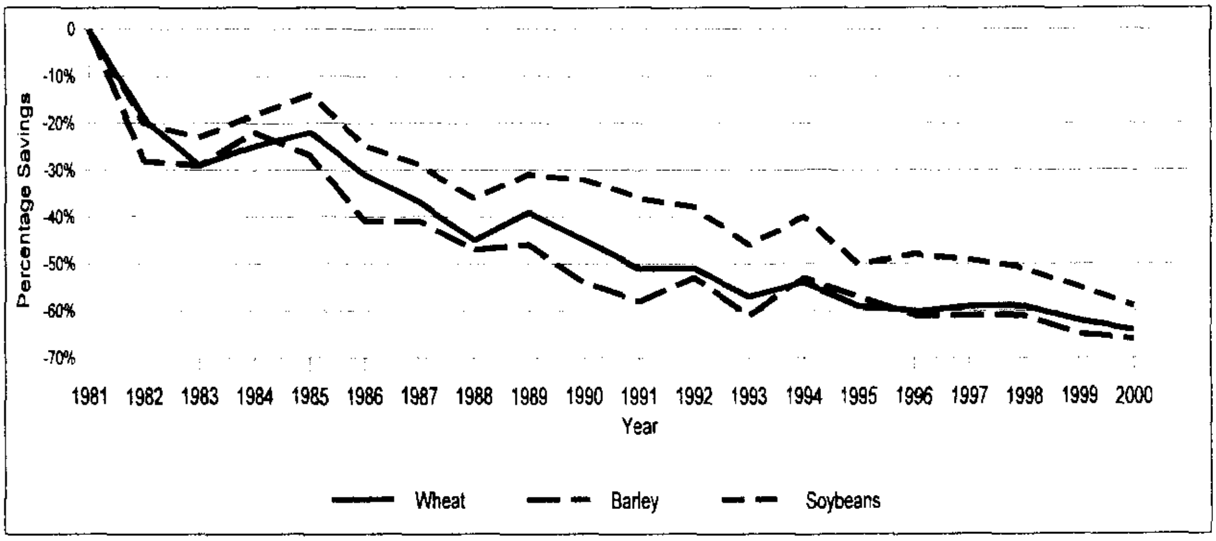

Figure 2. Cumulative percentage decrease in rates for wheat, barley, and soybean, 1981-2000, relative to 1981.

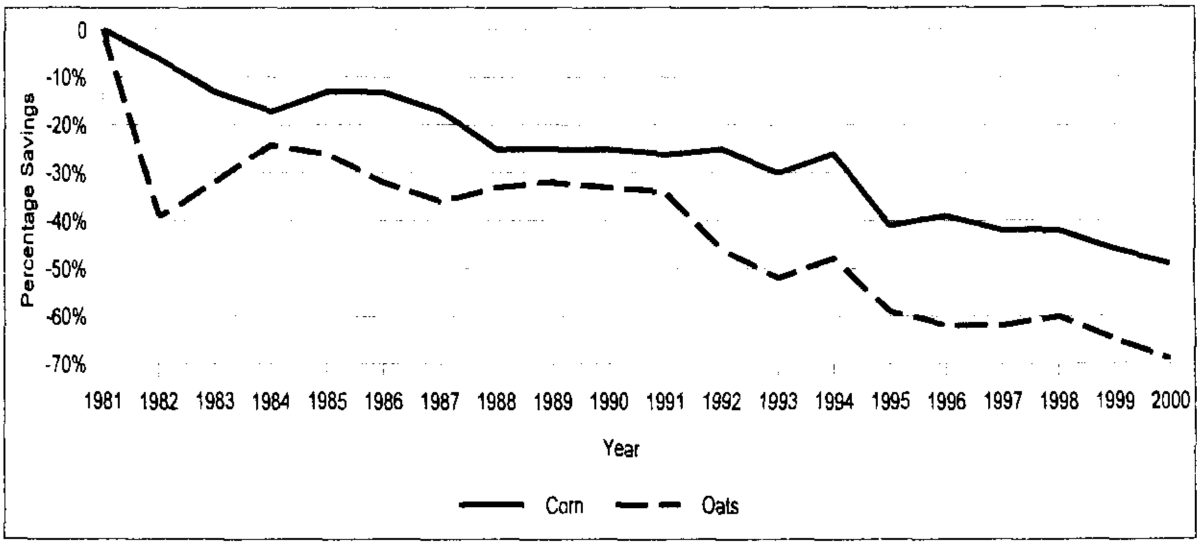

Figure 3. Cumulative percentage decrease in rates for corn and oat, 1981-2000, relative to 1981.

per ton-mile during the initial couple of years after deregulation took effect, with a slight trend adjustment in the mid-1980s for all grains. During the latter 1980s rates per ton-mile continued a downward shift until 1993-1994. At this time period rates for all grains increased, then shortly after continued to decrease but at a slower rate.

To better demonstrate the overall effect of time on rates since deregulation, Figure 4 shows the simulated rates for an average shipment of wheat, barley, corn, oat, and soybean from 1981 to 2000 at their respective mean levels. In this simulation, it is apparent that differential pricing among grain commodities did exist prior to or at the implementation of deregulation. Along with a dramatic decrease in rates over time since deregulation, it would appear there is a general convergence in rates during 2000. In the next section, an analysis of rail industry deregulation on rate differential among corn, soybean, and wheat by regions is presented.

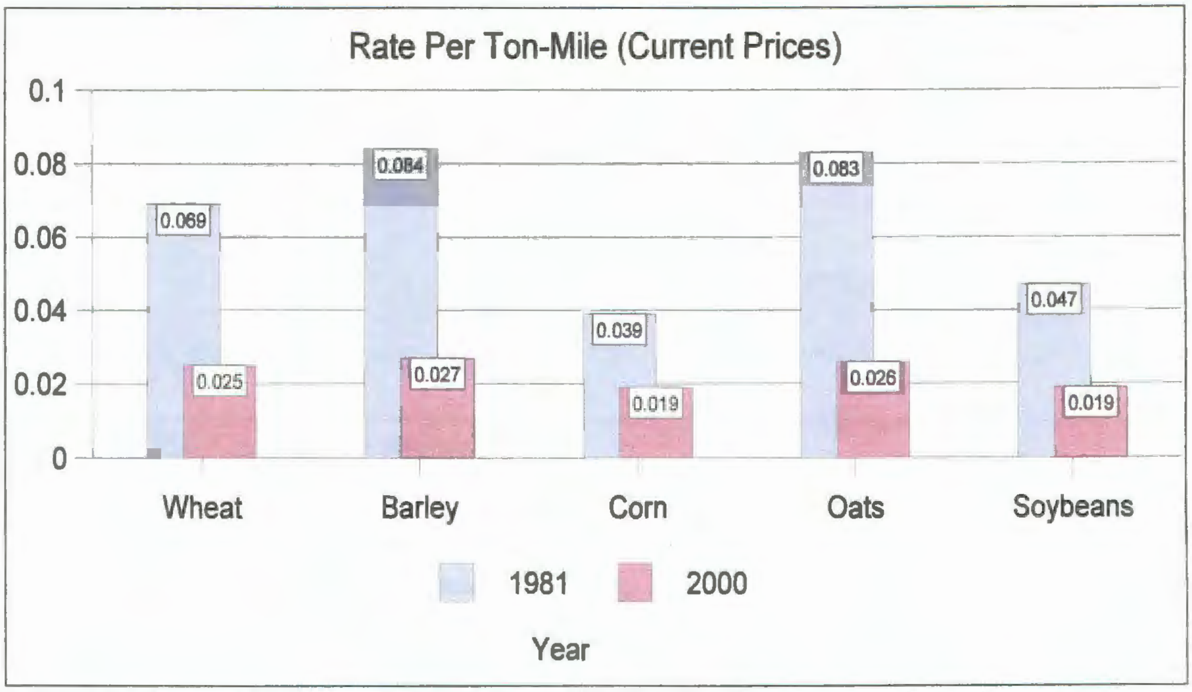

Figure 4. Simulated rates for wheat, barley, corn, oat, and soybean, 1981-2000. (All variables are placed at their mean levels.)

Regional Rail Rate Simulations for Corn, Soybean, and Wheat

In this section, simulations estimate rate per ton-mile for corn, soybean, and wheat to examine if there were differences in rail rate savings on a regional basis. Figure 5 shows the regions and the states that make up each region.[10]

Corn, soybean, and wheat accounted for approximately 92% of U.S. grain and oilseed production (60%, 17%, and 15% respectively) from 1996 and 2000 considering

Figure 5. USDA production regions.

[10]Pacific Northwest = Washington, Oregon, Idaho. West = California, Nevada, Utah, Arizona. Northern Plains = Montana, Wyoming, North Dakota, South Dakota. Central Plains = Colorado, Nebraska, Kansas. Southern Plains = New Mexico, Oklahoma, Texas. Western Corn Belt = Minnesota, Iowa. Delta = Arkansas, Louisiana, Mississippi. Eastern Corn Belt = Wisconsin, Illinois, Indiana, Michigan, Ohio. Northeast = Maine, New Hampshire, New York, Vermont, Massachusetts, Connecticut, Rhode Island, New Jersey, Delaware, Maryland, West Virginia. Southeast = Kentucky, Virginia, Tennessee, North Carolina, South Carolina, Alabama, Georgia, Florida.

production of eleven primary grains and oilseeds[11] (National Agricultural Statistic Service (NASS), 2003). The marketing and production characteristics for corn, soybean, and wheat vary, resulting in unique transportation demand functions among and within commodities. For example, the primary origin states for corn and soybean are similar, with Iowa and Illinois as the leaders in production. Wheat, in contrast, is concentrated west of the Mississippi in Kansas and North Dakota. In addition to the more western production region, wheat has subclasses including durum, spring, and winter. The qualities associated with these classes create distinct, yet interrelated, wheat markets with varying transport system demands and abilities. In comparison, corn and soybean products are each generally treated as homogeneous commodity markets with a high degree of substitutability within products, considering the range of quality characteristics.

Another difference in these grain commodities is their markets. Approximately 80% of corn production is used domestically. In contrast, only 65% of soybean, and 60% of wheat is consumed domestically. These differences contribute to the important differences in transport service demand for corn, soybean and wheat across time and geography.

Corn

Figures 6 through 11 illustrate average shipment and competitive characteristics for corn rail shipments from 1981 to 2000 across ten regions. Figure 6 shows the average cars

[11]Other commodities included in the U.S. grain production total are barley, cottonseed, flaxseed, oat, rice, rye, sorghum, and sunflower.

per shipment for corn shipments 1981 to 2000 and by originating region[12] 1981 to 2000. The average number of cars per shipment may be an indicator of rail investment by the origin regions to the degree it can be realized with access to markets capable of receiving larger rail shipments. As the figure shows, all regions averaged three or fewer cars per shipment in 1981, while all but two averaged five cars or more per shipment in 2000. The Western Corn Belt region had the largest increase in the number of cars per shipment in 2000 with an average of 26 from an average of two cars per shipment in 1981. This increase in shipment size may indicate an increased level of shipper investment by the

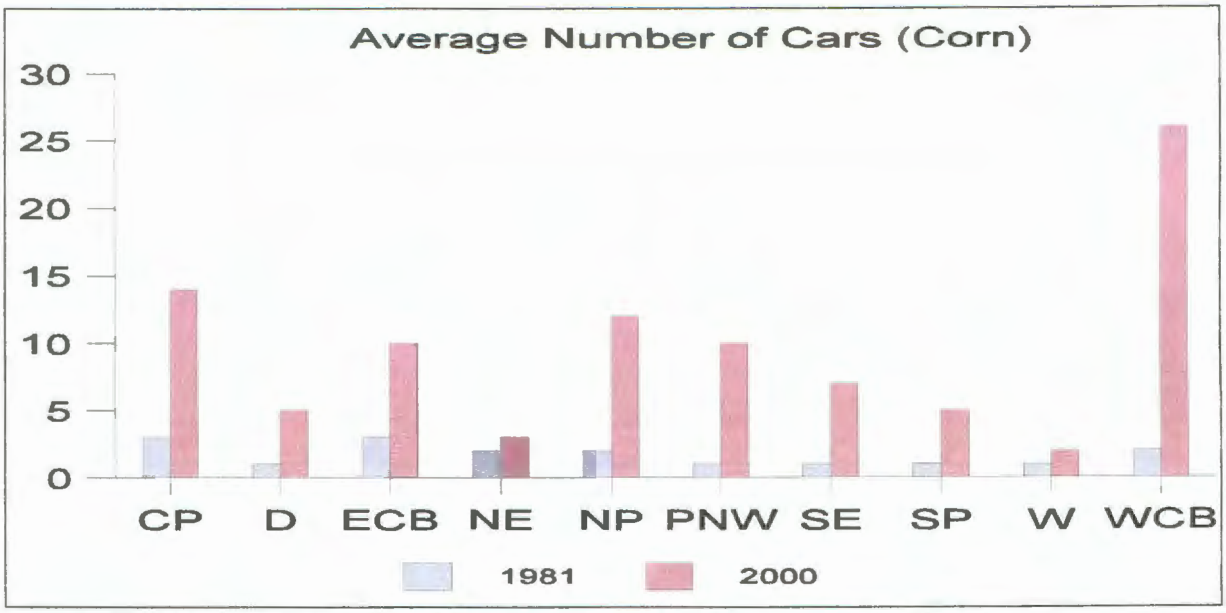

Figure 6. Average number of cars by originating region for corn, 1981-2000.

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[12]CP = Central Plains, D = Delta, ECB = Eastern Corn Belt, NE = Northeast, NP = Northern Plains, PNW = Pacific Northwest, SE = Southeast, SP = Southern Plains, W = West, and WCB = Western Corn Belt

expansion of elevators to accommodate larger shipments, in order to take advantage of rail marketing incentives.

Figure 7 shows short-line distance by region[13] in 1981-2000 for rail corn shipments. Most regions did not experience large increases in distances of shipments, with the exception of the Western Corn Belt which increased shipment distance from 540 miles to approximately 800 miles from 1981 to 2000. This shift in distance may be attributed to, as mentioned previously, factors such as greater consolidation at origin points in response to railroad marketing incentives and technological advances in grain production that have affected the production geography and density.

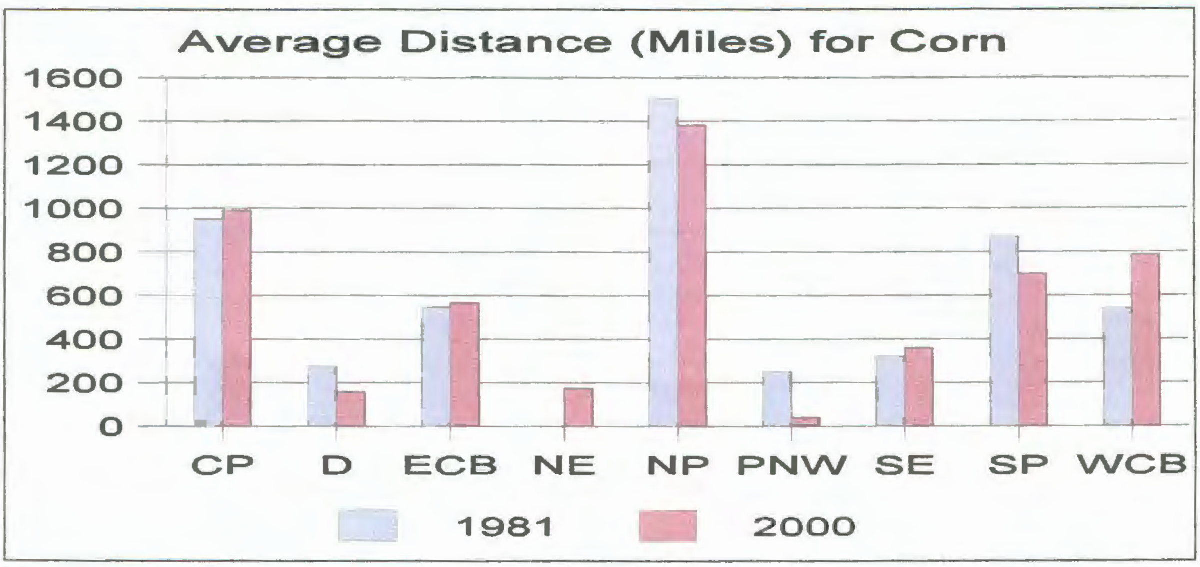

Figure 7. Average short-line distance by originating region for corn, 1981-2000.

[13]CP = Central Plains, D = Delta, ECB = Eastern Corn Belt, NE = Northeast, NP = Northern Plains, PNW = Pacific Northwest, SE = Southeast, SP = Southern Plains, W = West, and WCB = Western Corn Belt.

As Figure 8 shows, the average distance from the nearest barge loading facility for corn rail origins[14] is higher for Northern Plains, Southern Plains and West regions. Areas with origins close to barge loading facilities are located in the Delta, Eastern Corn Belt, Pacific Northwest and Southeast regions. Most of the production of corn in the United States is in close proximity to barge loading facilities. This could explain lower rates for corn as compared to wheat rates along with the high production of corn and its substitutability as feed products.

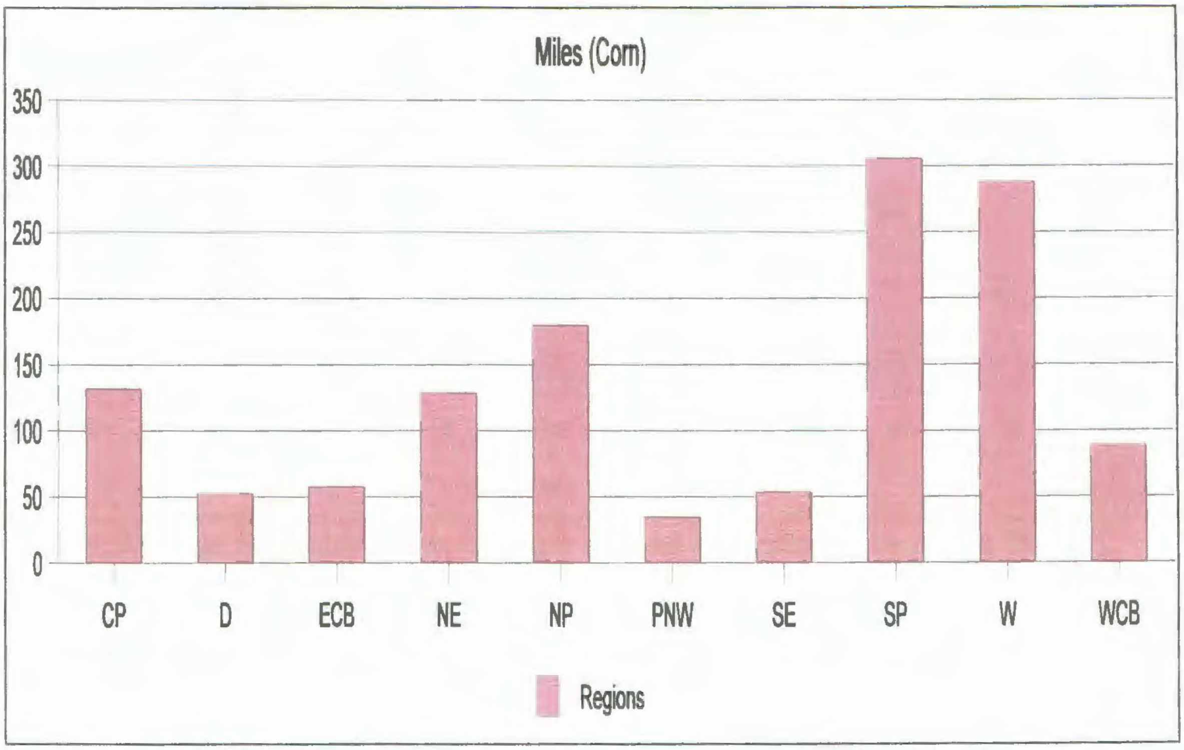

Figure 8. Average distance of shipment origins from nearest barge loading facility for corn, 1981-2000.

[14]CP = Central Plains, D = Delta, ECB = Eastern Corn Belt, NE = Northeast, NP = Northern Plains, PNW = Pacific Northwest, SE = Southeast, SP = Southern Plains, W = West, and WCB = Western Corn Belt.

Figure 9 shows the average Herfindahl Index of origin railroad concentration by region for the years 1981 to 2000. Five regions showed an increase in concentration over the 1981 to 2000 time period. The Pacific Northwest and West regions remained the same while the Eastern Corn Belt, Northeast, and Western Corn Belt decreased in concentration slightly over the 1981 to 2000 time period. Increases in concentration may reflect consolidation of rail companies along with the abandonment of unprofitable rail lines as well as larger unit-train facilities.

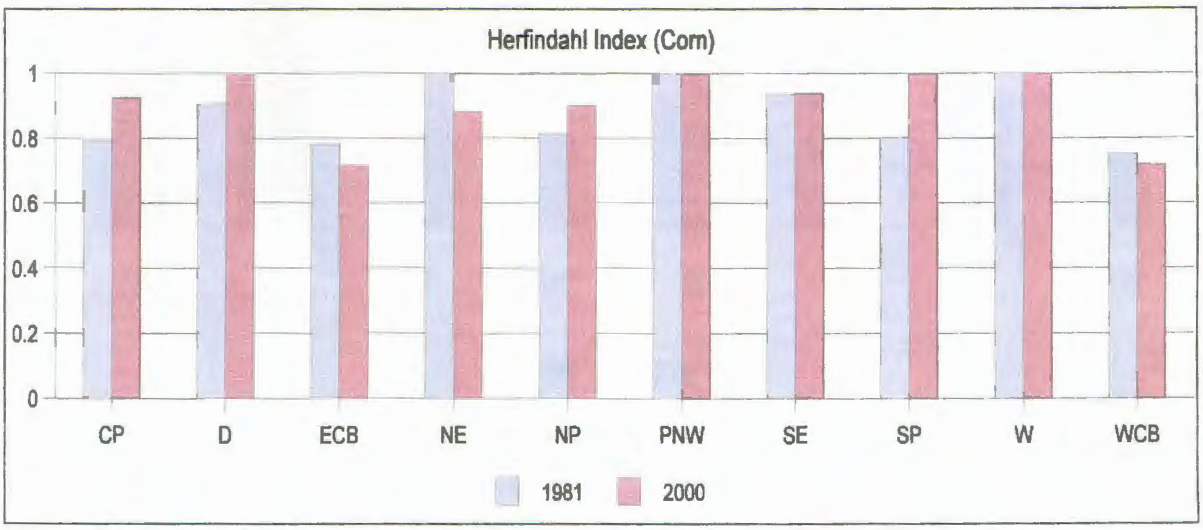

Figure 9. Average Herfindahl Index of origin railroad concentration by region for corn, 1981- 2000.

Figure 10 shows the simulated average corn rail rates by region in 1981 to 2000 obtained by placing all variables at mean levels by region and year. As the figure shows, large differences in rates exist among the regions in 1981, the initial year in the study that was reflective of rates effective under deregulation. During the 1981 to 2000 time period, decreases in rates averaged 37% across regions. Rate decreases ranged from 33% in the Delta to close to 40% in the Southern and Northern Plains.

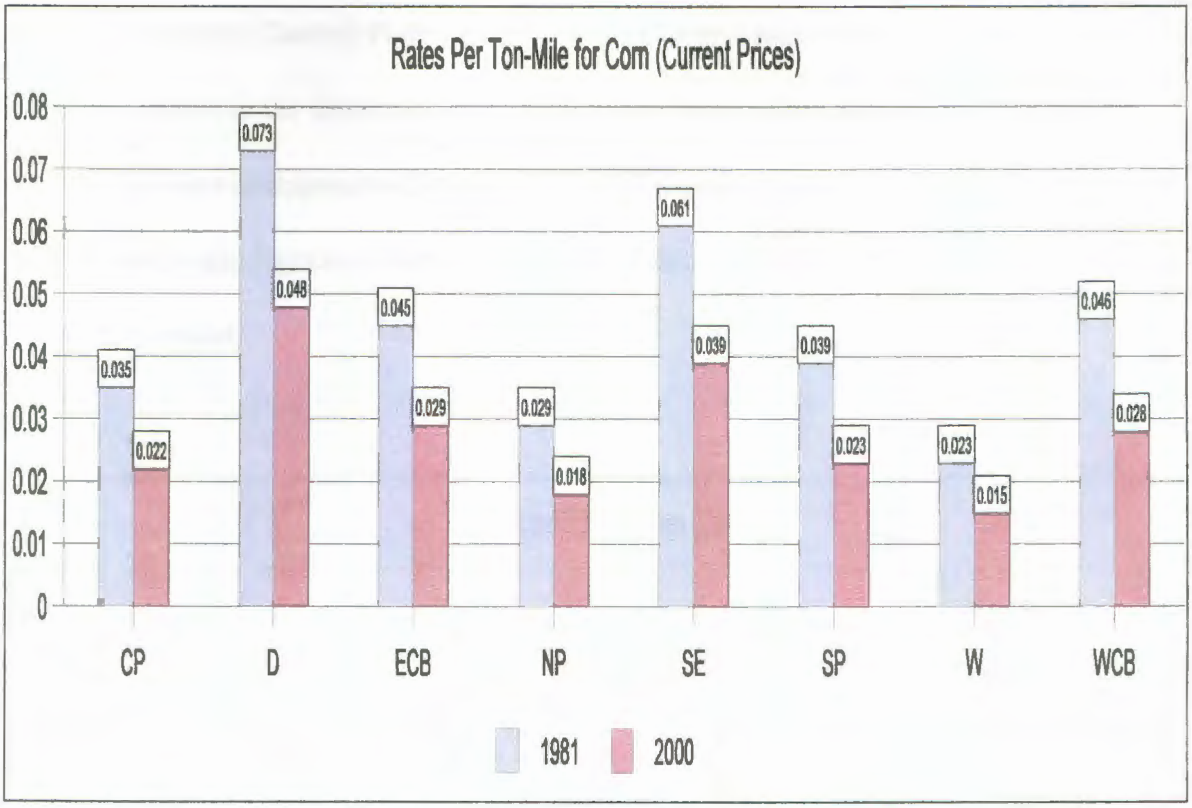

Figure 10. Simulated corn rates by region, 1981-2000 (all variables placed, except for time, at their 1981 mean levels for the region).

To gain more insight into the rate savings on corn shipments, simulations on rate savings due to the time trend and due to changes in time and independent variables were conducted. Changes due to the time trend reflect differences in intermodal, intramodal, geographic, and product competition among regions, while changes due to changing independent variables reflect changes in shipment efficiency due to larger and longer shipments and changes in demand elasticity variables.

Figure 11 shows the changes in these rates as simulated by the time trend and by the changes in shipment characteristics added to the time trend. As the figure shows, the Western Corn Belt, Central Plains, and Southern Plains experienced the largest decreases in rates attributable to the time trend. The region experiencing the largest rate savings as a result of changes in shipment characteristics and time was the Western Corn Belt region, as a result of its large increases in average shipment distances and average shipment size during this period.

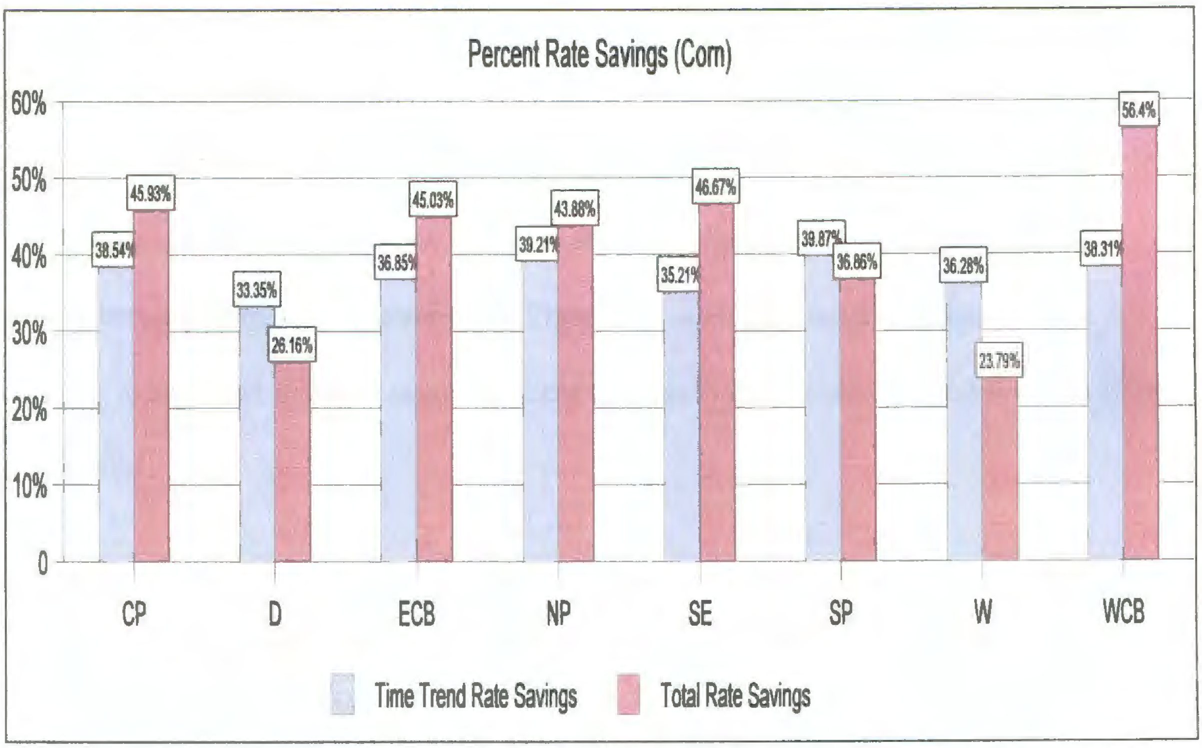

Figure 11. Simulated corn rate savings due to time trend and due to changes in time and shipment characteristics, 1981-2000.

Soybean

Rate savings for soybean shippers have varied just as they have for corn shippers. Figures 12 through 17[15] show shipment characteristics. Figure 12 shows the average rail cars per shipment for soybean, 1981-2000, by region.[16] As for corn, all regions averaged fewer than two cars per shipment in 1981, while only the Delta and South East regions averaged fewer than four cars per shipment in 2000. In comparison to corn, the increase in shipment size for soybean rail shipments has been much larger. In 2000, the Eastern Corn Belt, Northern Plains, Southern Plains, and Western Corn Belt regions averaged 17 cars per shipment, the largest increase in shipment size was 32 or more cars for the Central Plains region. As with corn, the increase in soybean shipment sizes during the 1981 to 2000 time period may be a result of rail marketing initiatives and the smaller geographic distribution of soybean production.

Average short-line distance, or the shortest rail distance between two points, for soybean shipments by region is shown in Figure 13. As illustrated in the figure, large increases in shipment distance occurred in the Central Plains, Southeast, and Western Corn Belt regions.

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[15]As in the case of corn, for illustrative purposes abbreviations will be used: CP = Central Plains, D = Delta, ECB = Eastern Corn Belt, NE = Northeast, NP = Northern Plains, PNW = Pacific Northwest, SE = Southeast, SP = Southern Plains, W = West, and WCB = Western Corn Belt.

[16]The Northern and Southern plains had too few shipments in 1981 to ensure reliable shipment mean characteristics.

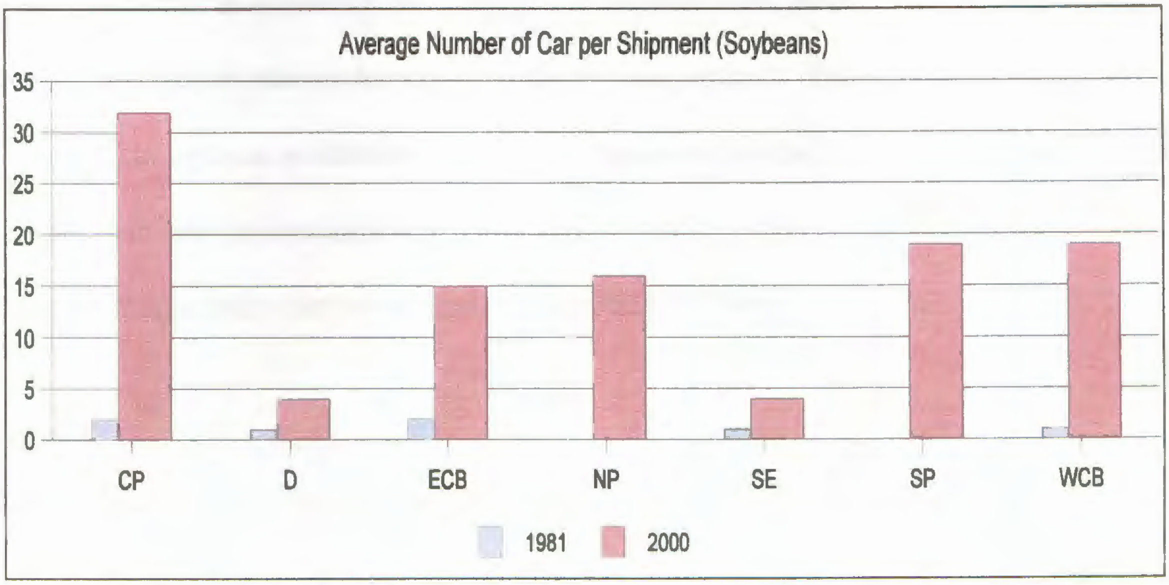

Figure 12. Average number of cars per shipment by originating region for soybean, 1981-2000.

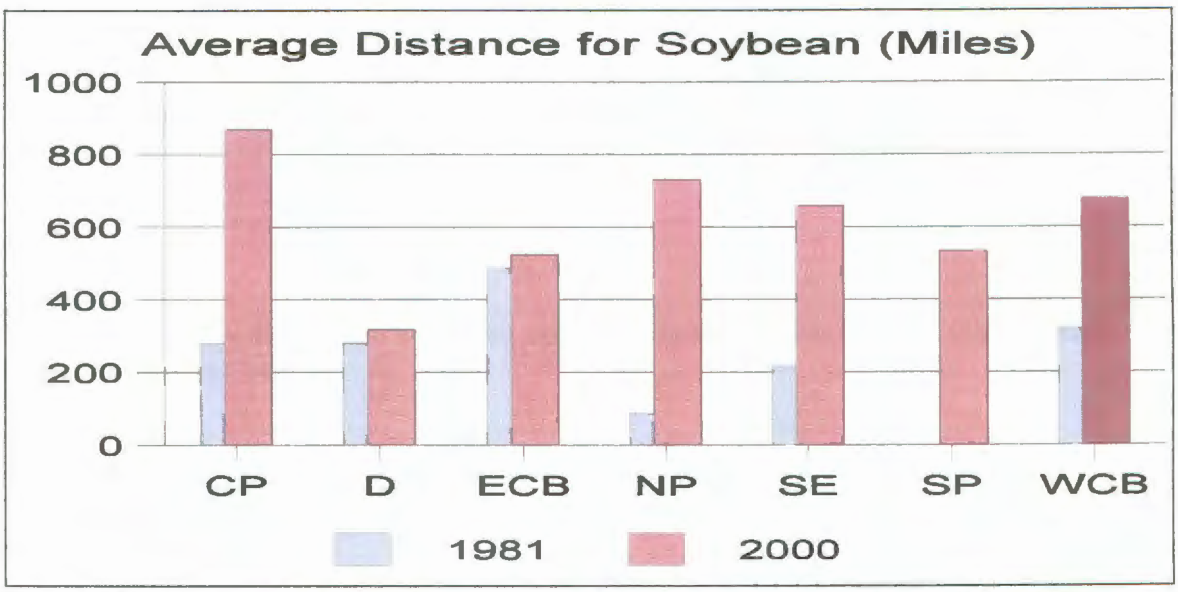

Figure 13. Average short-line distance by originating region for soybean, 1981-2000.

As shown in Figure 14, the average distances of origin points from the nearest barge loading facilities are shorter for soybean than for corn, overall. This is because areas most well suited to soybean production are closer to barge loading facilities. This would explain why soybean rates in comparison to corn rates are similar, while in contrast to wheat rates, soybean are less due to the overall geographical differences in production.

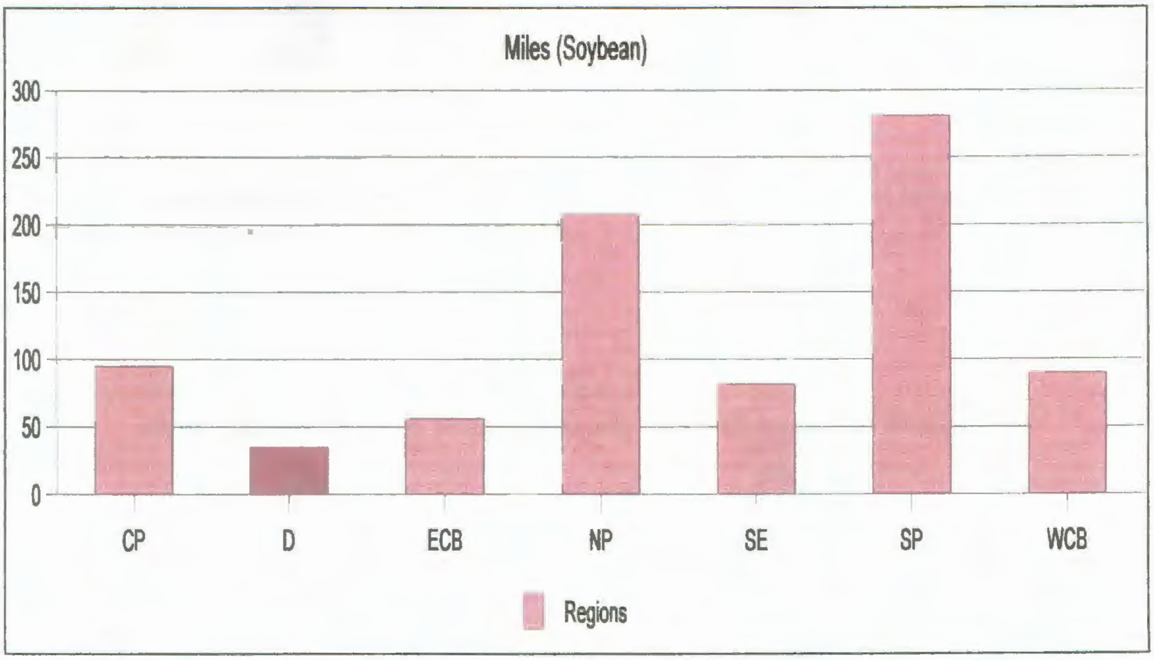

Figure 14. Average distance of shipment origins from the nearest barge loading facility for soybean, 1981-2000.

Figure 15 shows the average Herfindahl Index of origin railroad concentration for soybean shipments in 1981 and 2000, by region. Central Plains, Delta, and Eastern Corn Belt regions show an increase in origin railroad concentration between 1981 and 2000.

Simulated soybean rates by region are shown for 1981 and 2000 in Figure 16. Rail rates for soybean differ within regions. However, in general all regions experienced large decreases in rates between 1981 and 2000.

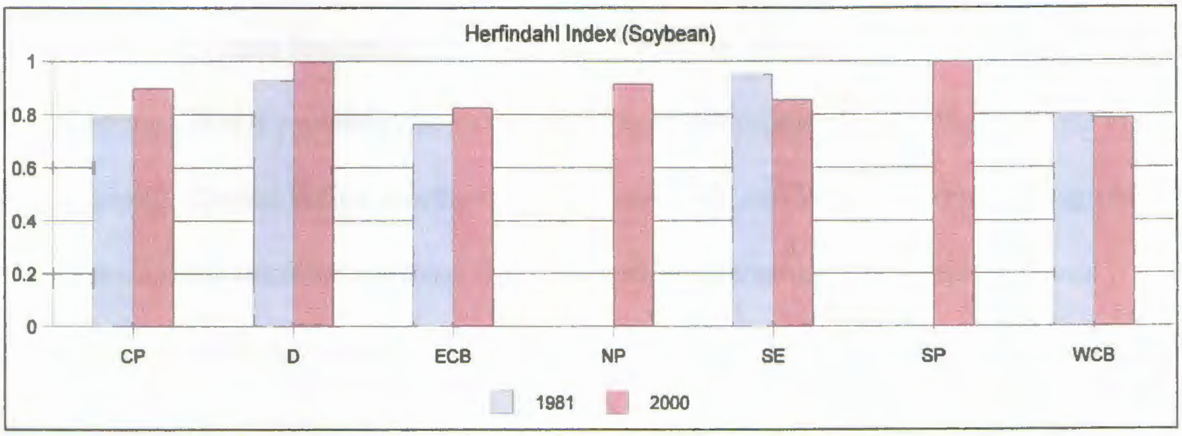

Figure 15. Average Herfindahl Index of origin railroad concentration by region for soybean, 1981-2000.

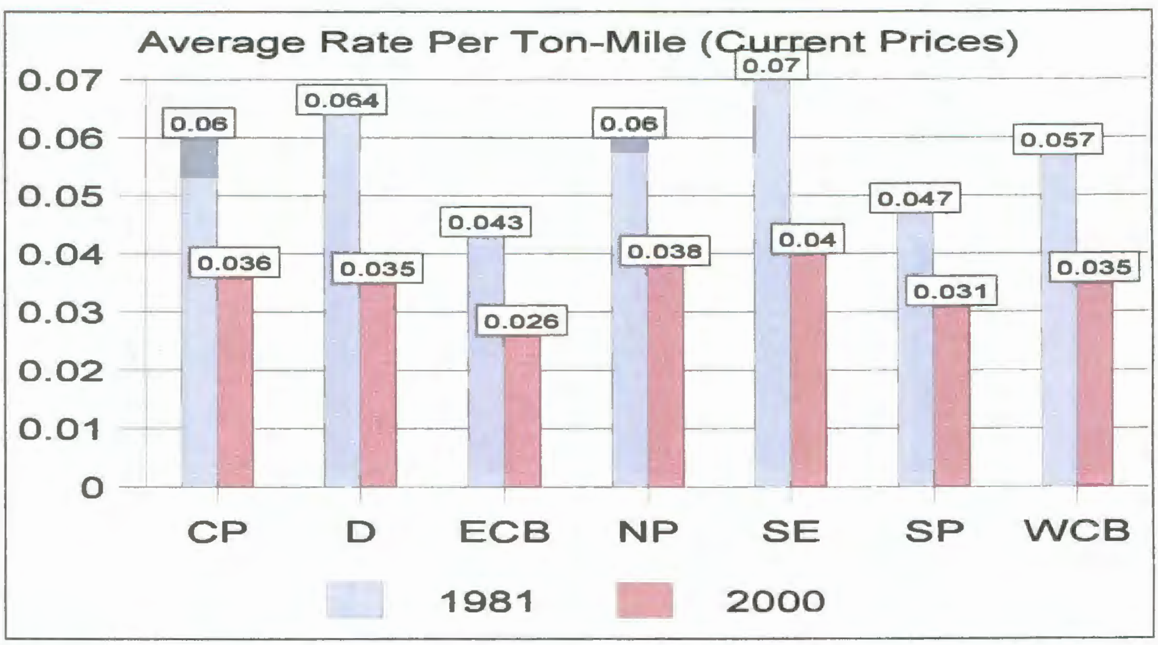

Figure 16. Simulated soybean rates by region, 1981- 2000. (All variables, except for time, are placed at 1981 mean levels.)

Figure 17 shows the simulated soybean rail rate savings for the regions between 1981 and 2000. The largest rate savings from the time trend alone are for the Central Plains, Delta, Southeast, and Western Corn Belt regions. The elasticity of demand for rail transportation in these regions is probably high due to the increased level of transportation competition. This is probably due to these regions close proximity to export markets or feed markets. Central Plains, Northern Plains, Southeast, and Western Corn Belt regions experienced the greatest rate savings from changes in shipment characteristics. These regions experienced more than a 53% increase in shipment distance. The Eastern Corn Belt and Delta regions only experienced 7% and 12% increases in shipment distances, which correspond to their lower percent rate savings due to shipment characteristics.

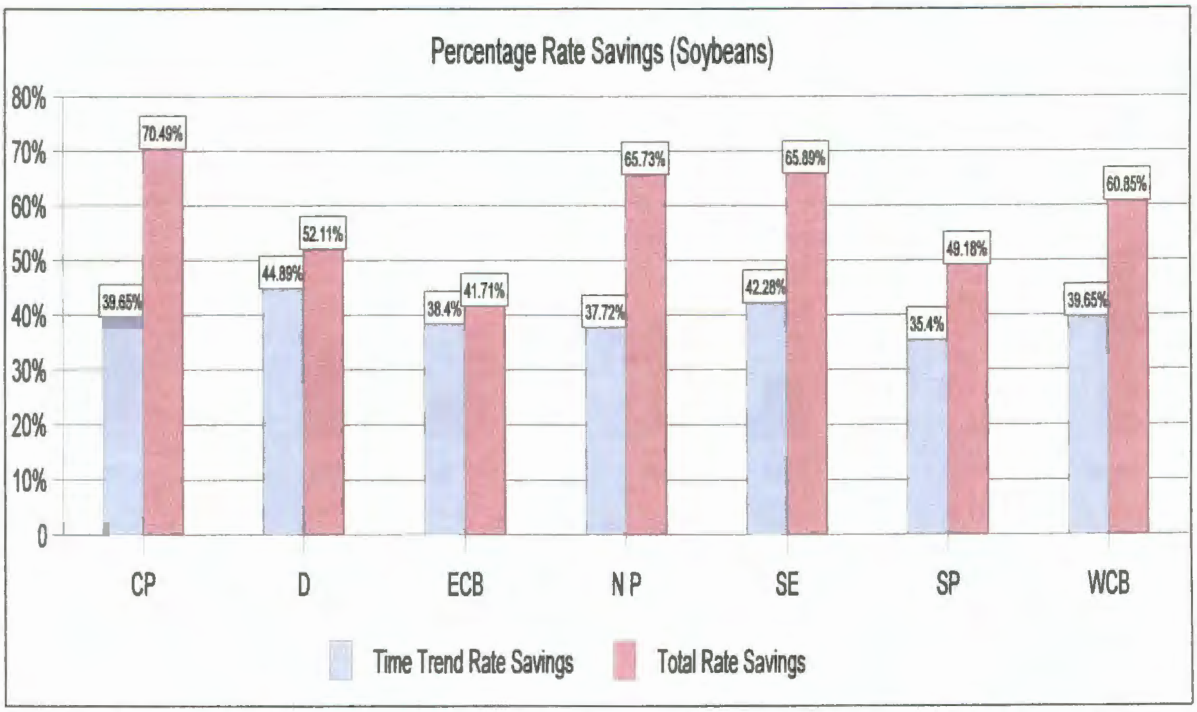

Figure 17. Simulated soybean rate savings due to time trend and changes in time and shipment characteristics, 1981-2000.

Wheat

Figure 18 shows the average cars per shipment for wheat shipments in 1981 and 2000, by region. All regions[17] averaged fewer than four cars per shipment in 1981 while only three regions averaged fewer than four cars in 2000. These regions, the Northeast, Southeast, and West, are primarily feed grain and small mill destinations, so there is little incentive for local shippers to invest in expanding rail capacity. Over the 1981 to 2000 period, several regions (Central Plains, Northern Plains, Southern Plains and Western Corn Belt) experienced large increases in shipment size. Given the increases in the size of shipments in these regions during this period, it would seem that shippers have increased their rail origination capacity to take advantage of rail rate incentives in their markets.

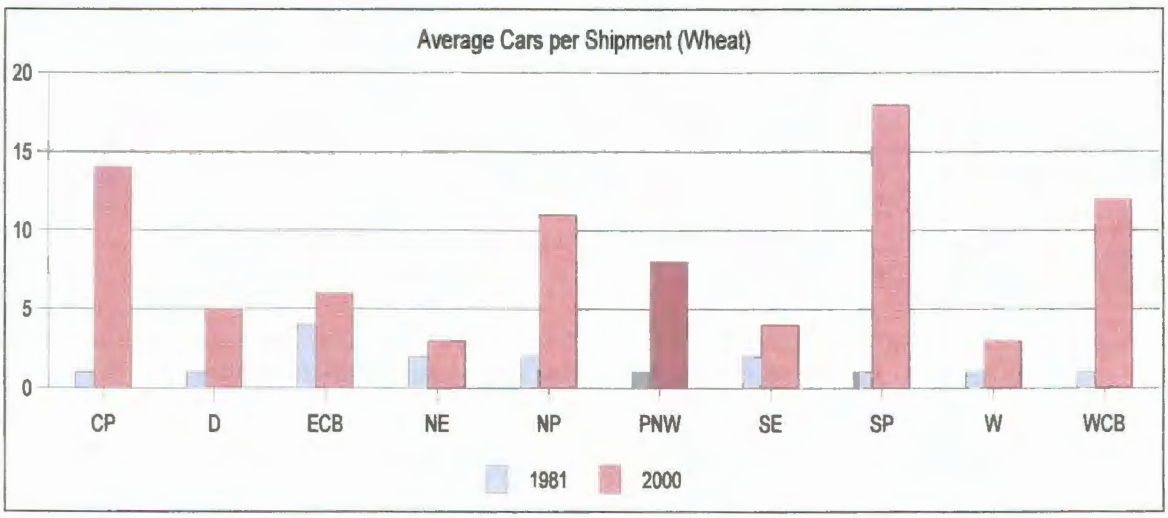

Figure 18. Average cars per shipment by originating region for wheat, 1981-2000.

[17]As in the case of corn, for illustrative purposes abbreviations will be used: CP = Central Plains, D = Delta, ECB = Eastern Corn Belt, NE = Northeast, NP = Northern Plains, PNW = Pacific Northwest, SE = Southeast, SP = Southern Plains, W = West, and WCB = Western Corn Belt.

Figure 19 shows the average short-line distance of wheat shipments for 1981 and 2000, by region. The shipment distance reflects incentives for inland shipment consolidation, including those related to trucking costs associated with production agriculture and those related to efficiency gains available to elevators, railroads, and terminal markets. During the 1981 to 2000 time period, the largest percentage increases in shipment distance were for the Southern Plains, Northern and Central Plains, and the Pacific Northwest, ranging from 53% to 44%.

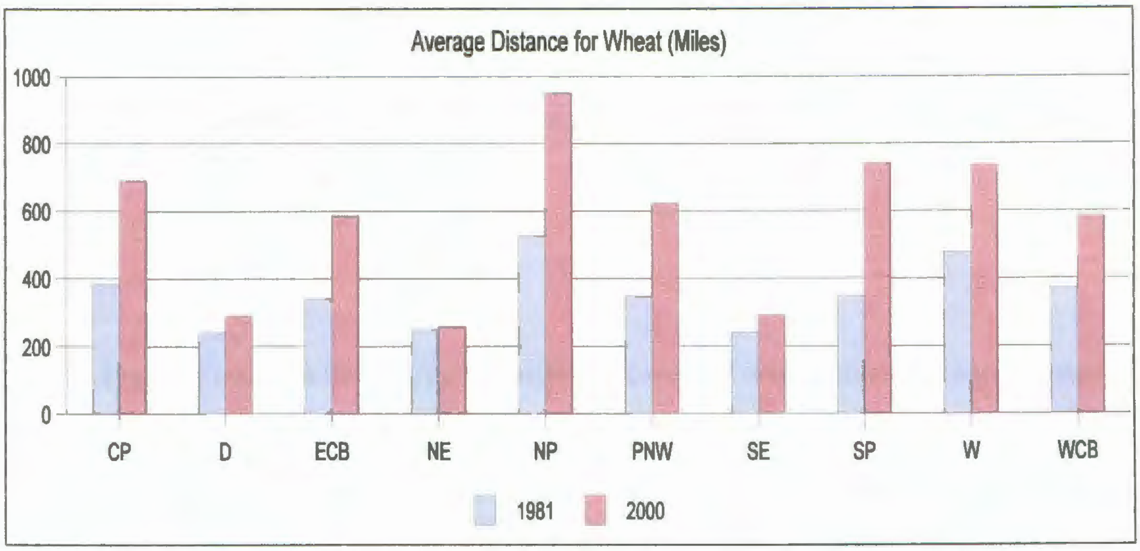

Figure 19. Average short-line distance of wheat shipments by region, 1981-2000.

Figure 20 shows the average distance of origin rail points for wheat from the nearest barge loading facility. As the distance from waterway access increases, the level of intermodal competition decreases accordingly. As shown in the figure, shipments originating in the Central Plains, Northern Plains, Southern Plains, and West regions experienced limited intermodal competition while those in Eastern Corn Belt, Delta, and Southeast experienced heavy intermodal competition.

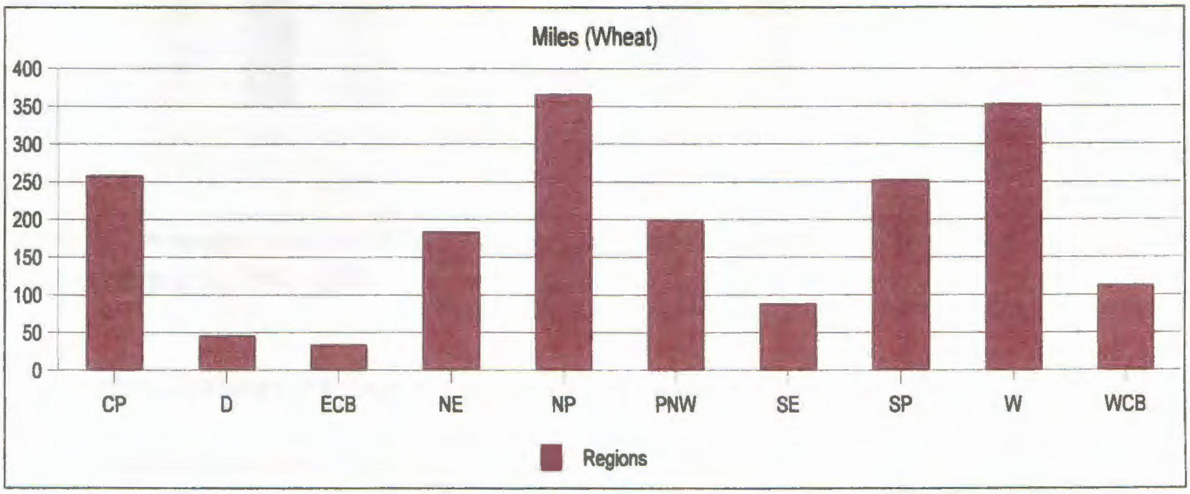

Figure 20. Average distance of shipment origin from the nearest barge loading facility for wheat shipments, 1981-2000.

Figure 21 shows the average Herfindahl Index of origin railroad concentration for wheat shipments in 1981 and 2000 by region. Six regions show an increase in origin railroad concentration, while the other four show a decrease. These decreases in the Eastern Corn Belt, Northeast, and Southeast generally show an increase in level of rail competition over the eastern regions of the Unites States. This is possibly due to the larger number of small railroads that operate in the East and greater track density as compared to the West in 1981. Increases in railroad concentration in the western regions may reflect a greater number of rail abandonments and the overall increase of consolidation among railroad companies.

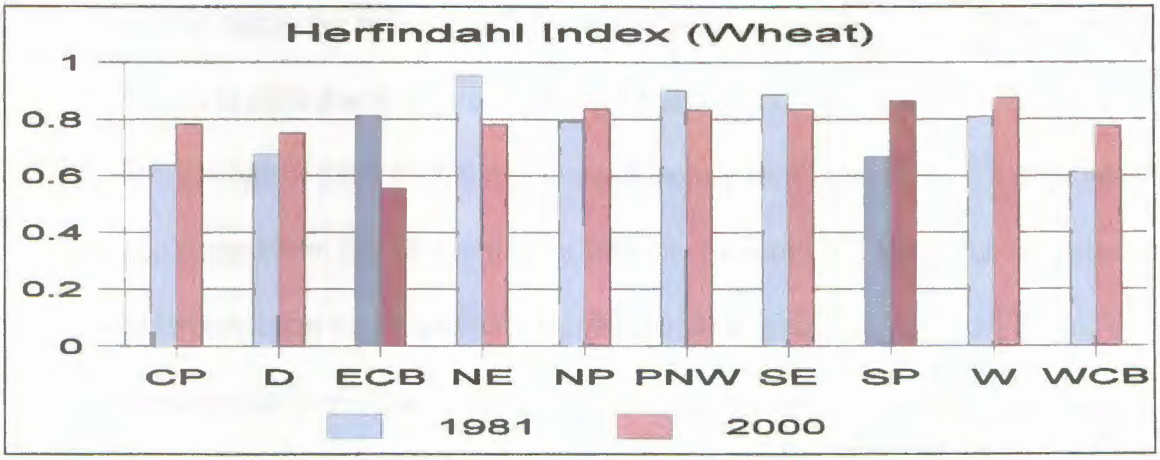

Figure 21. Average Herfindahl Index of origin railroad concentration by region for wheat shipments, 1981-2000.

Figure 22 shows simulated wheat rates by region for the time period of 1981 to 2000. As was the case for the other commodities, there were large decreases in rates over time that averaged 45% across the regions. The Southeast, Eastern Corn Belt, and the Delta regions experienced approximately 46% decreases in rates.

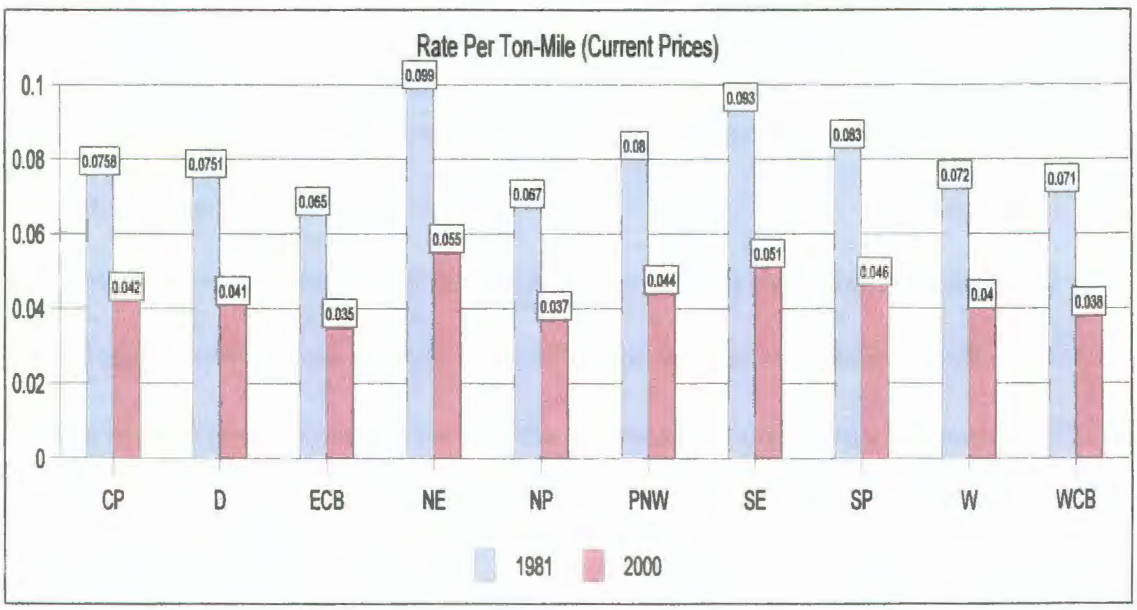

Figure 22. Simulated wheat rates by region, 1981-2000. (All variables, except for time, are placed at their 1981 mean levels for the region.)

Figure 23 shows the simulated overall wheat rate savings due to time trend and as a result of changes in rates due to time controlling for shipment characteristics. Regions realizing 45% savings or more from the time trend include three regions with a great deal of transportation competition (the Western Corn Belt, the Eastern Corn Belt, and the Delta region), and three that are major destination points for feed grain (the Southern Plains, the Central Plains, and the North East). This was to be expected since areas with waterway competition and nearby access to export facilities and areas with major feed markets where trucks are an alternative mode of transporting grain are likely to have a higher elasticity of demand for rail transportation. Due to a move to competitively determined rates as a result of deregulation, areas with high demand elasticity for rail transport are the areas where rate savings should be the highest. When examining the rate savings attributable to changes in shipment characteristics, areas with the largest gains relative to the time trend alone are the Central Plains, Eastern Corn Belt, Northern Plains, Pacific Northwest, Western Corn Belt,and the Southern Plains at 65%, 66%, 66% , 64%, 64%, 63%, and 70%, respectively. These areas realized increases in average shipment distance and increases in shipment size between 1981 and 2000.

As deregulation has had a negative impact on rates over time, it is expected that demand elasticity variables will play a more important role over time as shifts from cost-based to market-based pricing occur. In the following section, further discussion will be given to intermodal and intramodal competition, and their role in determining deregulation impacts.

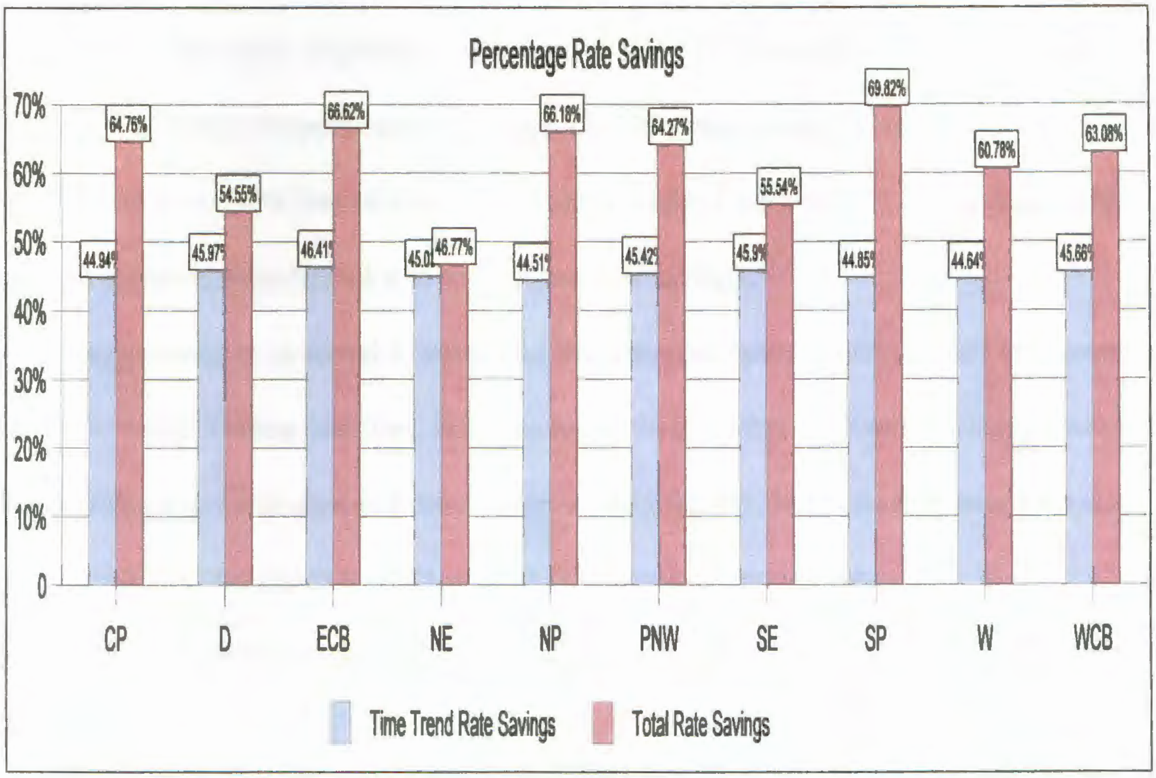

Figure 23. Simulated wheat rate savings due to time trend and due to changes in time controlling for shipment characteristics, 1981-2000.

Intermodal and Intramodal Competition Simulations

To demonstrate the effects of intermodal and intramodal competition on rail rates per ton-mile over time since deregulation, simulations were conducted with results shown in Tables A.1 through A.10 (Appendix) for wheat, barley, corn, oat, and soybean, respectively. Tables A.1, A.3, A.5, A.7, and A.9 show estimated rates in 1981 and 2000 for varying levels of intermodal competition.[18] Tables A.2, A.4, A.6, A.8, and A.10 show the estimated rates in 1981 and 2000 for different levels of intramodal competition.

[18]Obtained by varying distances from the nearest barge loading facilities while holding all else constant.

In 2000, wheat shippers have experienced between 63 to 67% savings in rail rates compared to 1981 rates, depending on various levels of intermodal competition.[19] In comparison, barley shippers experienced a 66 to 78% rate savings, corn shippers a experienced 40 to 52% rate savings, oat shippers realized a 66 to 71% rate savings, while soybean shippers experienced a 53 to 70% rail rate savings.[20]

In general, as expected it was found that when shippers for all grains[21] are located at or next to barge loading facilities, rail rates are at their lowest. Conversely, the greater the distance that a grain shipper is from a barge loading facility, rail rates increase. This was true, for most of the grains in 1981 and 2000, with the exception for corn.[22] In MacDonald's (1985) estimation on export movements to the Atlantic, Gulf, Pacific ports,

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[19]In this study, varying levels of intermodal competition are accomplished by running simulations keeping all the parameter estimates of the grain commodity regression models at their respective mean level, with the exception of distance to the nearest barge loading facility.

[20]These distances are based on distances to the nearest barge loading facilities that shippers within certain states encounter when determining the mode of transport for their commodity. This allows an analysis of the geographical effect of intermodal competition. Distances of 50 miles to the nearest barge loading facility would be typical of the following states: Washington, Ohio, Illinois, and Indiana. Distances of 100 miles: Georgia and Iowa. Distances of 200 miles: Minnesota and Oklahoma. Distances of 250 miles: Kansas and Nebraska. Distances of 300 miles: South Dakota. Distances of 400 miles: North Dakota. Distances of 500 miles: Wyoming and Montana. Finally, distances of 550 miles to the nearest barge loading facility would be typical for the state of Utah.

[21]Soybean rail rates decreased as competitive intermodal pressure was decreased due to a negative coefficient for ln Bdist in the regression.

[22]Simulated 2000 rates for corn were flat regardless of an increase in distance to the nearest barge loading facility.

and ports on the Great Lakes, wheat shippers 500 miles from water competition paid rates 36% greater than shippers 100 miles away. In comparison, this study finds that rail shipments 500 miles away from barge competition payed 24% higher rates in comparison to those 100 miles away from barge competition, and rail rates per ton-mile in 2000 were 26% greater for shippers 500 miles away in comparison to 100 miles away. Rail rates for shippers 50 miles from a barge loading facility experienced significant increases compared to shippers within a mile of barge loading facilities. In 1981, rates were 48% greater at 50 miles from barge facilities in comparison to 1 mile from barge loading facilites, and in 2000, rates were approximately 50% greater. Thus, direct barge access offers a distinct advantage to shippers since they have experienced greater rate savings in comparison to shippers located without direct access to barge facilities, and acts as a major constraint on rail rates.

In Tables A.2, A.4, A.6, A.8, and A.10, the results of intramodal competition on rail rates per ton-mile for wheat indicate that rate savings range from 63.92% to 64.13% when compared to 1981 rail rates. Barley shippers saved between 51.84% and 71.52%. Rail rates for oat shippers produced a savings of 66.59% to 69.03% in 2000 compared to 1981 rates. Soybean shippers also realized a savings of 45.59% to 62.18% during the same time period. In the case of barley, oat, and soybean, results indicate an increase in the market power of competing railroads within a county, resulting in larger decreases in rail rates, the opposite effect of what logic would dictate. A potential reason for this is that the Herfindahl-Hirschman Index within a county may not be an appropriate measure of intramodal competition.[23]

Competitive effects for intramodal competition in wheat and corn (Table A.2 and A.6) confirms that as the Herfindahl-Hirschman Index approached 1.00, signifying monopolistic market power, rates increased in comparison to those markets experiencing lower levels of intramodal competition. Rail rates increase when shippers have an inelastic demand for rail.

Table A.11 shows the influence of BDIST and HERF on rates for wheat, barley, corn, oat, and soybean in 1981 and 2000. Clearly, intermodal competition has increased in importance for wheat, barley, oat, and soybean. Longer distances to barge loading facilities mean less intermodal competition considering 1% percent increase in the distance to the nearest barge loading facility in 1981 resulted in a 0.11% increase in rail rate per ton-mile. In 2000, a 1% increase in the distance to the nearest barge loading facility resulted in a 0.13% increase in rate per ton-mile. For barley shippers, a 1% increase in the distance to the nearest barge loading facility resulted in an increase of 0.07% in 1981, and an increase of 0.14% in 2000. For oat it was found that a 1% increase in the distance to the nearest barge loading facility resulted in an increase of 0.019% in 1981 and an increase of 0.043% in 2000.

The parameter for the time interaction with the Herfindahl-Hirschman Index of origin railroad concentration shows unexpectedly decreasing importance over time for all commodities except corn.[24] This is possibly due to the increasing importance of truck

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[23]Explained further at the end of the section.

[24] Corn intramodal elasticity increased from -0.019 in 1981 to 0.139 in 2000.

competition as one of the market factors in rate setting. As trucks increase in size and length of haul, railroads compete over larger geographic areas. As the Herfindahl-Hirschman Index is the concentration of railroads calculated by county of origin, this index may prove to be increasingly irrelevant as railroads compete over larger geographic areas.

In the next chapter, conclusions and policy implications are discussed.

CHAPTER 6
CONCLUSIONS

Although the original intent of this study was to do a pre- and post-deregulation assessment of rail rates per ton-mile, the results using post-deregulation data show a significant decrease in rail rates between 1981 and 2000. When accounting for changes in shipment characteristics for wheat, barley, corn, oat, and soybean, rate savings were 63.79%, 67.47%, 49.15%, 68.58%, and 58.89%, respectively. Rate savings due to time trend alone are 44.94%, 46.87%, 38.06%, 44.55%, and 36.32% for wheat, barley, corn, oat, and soybean shippers, respectively.[1]

Analysis of the variables affecting elasticities of demand for rail in a pre-deregulation and post-deregulation study had to be modified to a post-deregulation study due to data issues. These data issues were inaccurate or missing observations[2] for earlier pre-deregulation Annual Rail Waybill Sample Data and a written disclaimer by the Surface Board Transportation as to the accuracy of earlier Annual Rail Waybill Sample Data.

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[1]These results are similar to those found in other studies. For example, in the MacDonald (1989) study, between 1981 and 1985, wheat rates dropped an average of 21.7% . During the same time period, this study found that wheat rates decreased 21.6%, accounting for changes in shipment characteristics. Corn in MacDonald's study dropped 12.4%, accounting for changes in shipment characteristics. In comparison, corn in this study decreased 13.05% during 1981-1985. In the Dennis (2000) study, rail rates for agricultural products during 1982-1996 dropped an average of 48.1%. In this study, during the same time period, when combining wheat, corn, and soybean movements, which account for 92% of grain commodities, rail rates declined an average of 40%.

[2]Observations for the variable short-line miles was missing between 1972 and 1984. Observations for weight per car, in some cases, were either under or overstated.

In spite of its modification, this study should prove to be useful in the assessment of the impacts deregulation has had on rail rates for grain shippers. By using data from 1981 to 2000, time and other variables affecting elasticity of demand still provide important insight into the impact of deregulation on rail rates.

In this study of wheat, barley, corn, oat, and soybean, price differentiation is found to occur in two ways: by commodity and by geographic regions. As evidenced from the results, one of the implications of this study is, despite geographical and commodity differentiation, all shippers have experienced significant rail rate savings since deregulation. Barley was found to have the highest rate per ton-mile in 2000 at $.027 per ton-mile while, corn and soybean are on the lower end of the spectrum at $.019 per ton-mile. The tendency for railroads to implement more market-based pricing in recent years implies that rail demand elasticity is becoming an increasingly important factor in the relative competitiveness of U.S. grain producers.

When analyzing the effects of deregulation on rail rates for corn, soybean confirmed that rail rates not only differed across commodities, but also among regions. In general, it is found that grain producers within regions that had higher levels of intermodal competition had lower rates than their counterparts with lower levels of intermodal competition. Distribution of benefits, in the form of rate savings as a result of market-based pricing, has varied between regions, but all regions have experienced substantial benefits.

Based on the results of this study, policy makers such as Congress, the Surface Transportation Board, and the United States Department of Agriculture, should not consider regional reregulation, based on the simple fact that captive shippers have experienced significant declines in rail rates through gains in efficiency and productivity as a result of deregulation.

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APPENDIX

Table A.1. Simulation results: intermodal wheat model

Distance to Barge	Typical of State	Simulated 1981 RPTM	Simulated 2000 RPTM	Percent Rate Savings
1		$0.0305	$0.0101	67.02%
50	WA, OH, IL, IN	$0.0591	$0.0201	64.72%
100	GA, IA	$0.0665	$0.0237	64.29%
200	MN, OK	$0.0747	$0.0270	63.87%
250	KS, NE	$0.0776	$0.0281	63.73%
300	SD	$0.0800	$0.0291	63.61%
400	ND	$0.0840	$0.0307	63.43%
500	WY,MT	$0.0872	$0.0320	63.29%
550	UT	$0.0886	$0.0326	63.23%

Table A.2. Simulation results: intramodal wheat model.

Herf Index	Simulated 1981 RPTM	Simulated 2000 RPTM	Percent Rate Savings
.333*	$0.0727	$0.0262	63.92%
0.40	$0.0735	$0.0265	63.95%
0.5	$0.0745	$0.0268	64.00%
0.6	$0.0753	$0.0271	64.02%
0.7	$0.0760	$0.0273	64.05%
0.8	$0.0766	$0.0275	64.08%
0.9	$0.0771	$0.0277	64.11%
1	$0.0776	$0.0277	64.13%

* .333 = 3 Railroad's equal share.

Table A.3. Simulation results: intermodal barley model.

Distance to Barge	Typical of State	Simulated 1981 RPTM	Simulated 2000 RPTM	Percent Rate Savings
1		$0.0508	$0.0110	78.35%
50	WA, OH, IL, IN	$0.0635	$0.0181	71.43%
100	GA, IA	$0.0660	$0.0198	70.00%
200	MN, OK	$0.0687	$0.0217	68.48%
250	KS, NE	$0.0696	$0.0223	67.98%
300	SD	$0.0703	$0.0228	67.56%
400	ND	$0.0714	$0.0237	66.89%
500	WY,MT	$0.0723	$0.0243	66.36%
550	UT	$0.0727	$0.0246	66.14%

Table A.4. Simulation results: intramodal barley model.

Herf Index	Simulated 1981 RPTM	Simulated 2000 RPTM	Percent Rate Savings
.333*	$0.0537	$0.0259	51.84%
0.40	$0.0570	$0.0251	55.88%
0.5	$0.0612	$0.0243	60.34%
0.6	$0.0650	$0.0236	63.65%
0.7	$0.0683	$0.0231	66.23%
0.8	$0.0713	$0.0226	68.31%
0.9	$0.0741	$0.0222	70.05%
1	$0.0767	$0.0218	71.52%

* .333 = 3 Railroad's equal share.

Table A.5. Simulation results: intermodal corn model.

Distance to Barge	Typical of State	Simulated 1981 RPTM	Simulated 2000 RPTM	Percent Rate Savings
1		$0.0328	$0.0196	40.36%
50	WA, OH, IL, IN	$0.0378	$0.0197	47.98%
100	GA, IA	$0.0388	$0.0197	49.23%
200	MN, OK	$0.0397	$0.0197	50.44%
250	KS, NE	$0.0401	$0.0197	50.83%
300	SD	$0.0403	$0.0197	51.14%
400	ND	$0.0408	$0.0197	51.63%
500	WY,MT	$0.0411	$0.0197	52.01%
550	UT	$0.0412	$0.0197	52.17%

Table A.6. Simulation results: intramodal corn model.

Herf Index	Simulated 1981 RPTM	Simulated 2000 RPTM	Percent Rate Savings
.333*	$0.0393	$0.0175	55.42%
0.40	$0.0391	$0.0180	54.11%
0.5	$0.0390	$0.0185	52.47%
0.6	$0.0388	$0.0190	51.08%
0.7	$0.0387	$0.0194	49.87%
0.8	$0.0386	$0.0198	48.81%
0.9	$0.0385	$0.0201	47.79%
1	$0.0385	$0.0204	47.01%

* .333 = 3 Railroad's equal share.

Table A.7. Simulation results: intermodal oat model.

Distance to Barge	Typical of State	Simulated 1981 RPTM	Simulated 2000 RPTM	Percent Rate Savings
1		$0.0700	$0.0202	71.10%
50	WA, OH, IL, IN	$0.0716	$0.0227	68.29%
100	GA, IA	$0.0719	$0.0232	67.76%
200	MN, OK	$0.0722	$0.0237	67.23%
250	KS, NE	$0.0723	$0.0238	67.05%
300	SD	$0.0723	$0.0239	66.91%
400	ND	$0.0724	$0.0241	66.68%
500	WY,MT	$0.0725	$0.0243	66.51%
550	UT	$0.0726	$0.0244	66.43%

Table A.8. Simulation results: intramodal oat model.

Herf Index	Simulated 1981 RPTM	Simulated 2000 RPTM	Percent Rate Savings
.333*	$0.0707	$0.0236	66.59%
0.40	$0.071	$0.0234	67.01%
0.5	$0.0713	$0.0232	67.51%
0.6	$0.0716	$0.0230	67.92%
0.7	$0.0718	$0.0228	68.26%
0.8	$0.0720	$0.0227	68.55%
0.9	$0.0722	$0.0226	68.81%
1	$0.0723	$0.0224	69.03%

* .333 = 3 Railroad's equal share.

Table A.9. Simulation results: intermodal soybean model.

Distance to Barge	Typical of State	Simulated 1981 RPTM	Simulated 2000 RPTM	Percent Rate Savings
1		$0.0456	$0.0136	70.28%
50	WA, OH, IL, IN	$0.0402	$0.0157	60.90%
100	GA, IA	$0.0394	$0.0162	58.96%
200	MN, OK	$0.0385	$0.0166	56.91%
250	KS, NE	$0.0382	$0.0167	56.23%
300	SD	$0.0380	$0.0169	55.67%
400	ND	$0.0377	$0.0170	54.77%
500	WY,MT	$0.0374	$0.0172	54.05%
550	UT	$0.0373	$0.0172	53.74%

Table A.10. Simulation results: intramodal soybean model.

Herf Index	Simulated 1981 RPTM	Simulated 2000 RPTM	Percent Rate Savings
.333*	$0.0387	$0.0211	45.59%
0.40	$0.0389	$0.0199	48.78%
0.5	$0.0392	$0.0186	52.43%
0.6	$0.0394	$0.0176	55.21%
0.7	$0.0395	$0.0168	57.44%
0.8	$0.0397	$0.0162	59.19%
0.9	$0.0398	$0.0156	60.83%
1	$0.0399	$0.0151	62.18%

* .333 = 3 Railroad's equal share.

Table A.11. Intermodal and intramodal elasticities for wheat, barley, corn, oats, and soybean.

		Wheat	Barley	Corn	Oats	Soybean
Intermodal	1981	0.113	0.07	0.03	0.019	-0.011
Elasticities	2000	0.13	0.14	- 0.005	0.043	0.059
Intramodal	1981	0.059	0.32	-0.019	0.021	0.282
Elasticities	2000	0.053	-0.154	0.139	-0.049	-0.048